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NUCLEAR WEAPONS EFFECTS, GENERAL PURPOSE FORCES, AND THE BUILDUP IN VIETNAM, 1965–1969

In tracing the broad outlines of American military history since World War II, certain periods are characterized by major themes. After the Korean War, President Eisenhower relied mainly on America's nuclear arsenal and the threat of massive retaliation. During the Kennedy administration, this preoccupation with nuclear weapons waned as the United States developed more extensive conventional war forces. While the Johnson years presented no dramatic changes in military doctrine, there was an overriding theme—the war in Vietnam. From the introduction of American ground combat forces in 1965 until their withdrawal in 1973, the Vietnam involvement grew both in scope and then in impact until the war seemed to dominate all facets of American political and military life. Certainly the problems and frustrations of the intractable war preoccupied the American military, especially the Army, which bore the brunt of the American involvement.

Yet the war in Vietnam did not push all other issues aside. While matters not related to the war tended to fade from the public view, the military establishment still had other problems and other geographic areas that required attention. The expansion of the Soviet strategic nuclear arsenal in the late 1960s raised new and vexing questions about the nuclear weapons balance. And although Southeast Asia took precedence, Europe, Northeast Asia, and areas of the Third World were still important to the United States.[1] Military officials and planners continued to face an array of problems far removed from Vietnam.

Not only did the military staffs in Washington have a broad spectrum of concerns, but they also had a different relationship to the war in Vietnam than the commanders on the scene. Commanders in the field decided on day-to-day operations of combat forces under their control, while the military establishment in Washington provided broad guidance, generally as an agent of the President. The staffs' greatest concerns, however, were providing the commanders with troops and supplies and continuing their function as planners for mid- and long-range contingencies. As a staff support agency for the Department of the Army and the General Staff, the Engineer Strategic Studies Group (ESSG) reflected the concerns

of its superiors.[2] Although the group did a substantial amount of work on Vietnam problems, it concentrated on a future in which the war in Southeast Asia did not figure prominently or at least appeared as only one subject area among many others. In fact, by the early 1970s, the war had faded so markedly as a future concern that ESSG virtually ceased planning for contingencies in Southeast Asia. Even before the war ended for the United States, the group was attempting to identify and consolidate those lessons learned in Vietnam that might someday be useful.

While it might be tempting to categorize the periods from 1965 to 1973 or from 1965 to 1969 as the Vietnam era in ESSG's history, that categorization would be simplistic. No dramatic breaks occurred in 1965 or in 1969. ESSG studies relating to the war came predominantly in the late 1960s, and after 1969 the studies on Vietnam tended to be more retrospective. However, even these lines cannot be firmly drawn. A more dramatic break in ESSG's history occurred after 1969, when the studies of nuclear weapons and their effects declined markedly. In any event, studies involving both Southeast Asia and nuclear weapons comprised only half of ESSG's output in the late 1960s while a wide variety of topics, some new and some outgrowths of earlier work, kept the organization's interests varied and in tune with the broad range of subjects that concerned the Army and the Defense Department. So while the period had no theme as dominant as that in some earlier times, the years from 1965 to 1969 saw a growth in the diversity of the group's interests and a consolidation of its skill in subjects studied earlier in its history.

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Although in the late 1960s the United States became increasingly preoccupied with its conventional ground war in Southeast Asia, the overriding problem of general nuclear war remained a major military concern. By 1965 the massive nuclear weapons-building program, begun during the Eisenhower administration and accelerated by President Kennedy, had produced a large strategic arsenal. The force consisted of more than a thousand land-based intercontinental missiles, a fleet of 41 missile-launching submarines, and some 600 strategic bombers. By the mid-1960s the United States had a preponderance of strategic weapons.[3]

Backed by this arsenal, Secretary of Defense McNamara brought America's strategic nuclear doctrine into clear focus. After a period of inquiry and clarification in the early 1960s, the United States officially deemphasized the counterforce strategy of the Eisenhower era and replaced it with the doctrine of mutual assured destruction. McNamara's strategy had two major objectives. The first was "assured destruction"; the United States would deter an attack by maintaining a "clear and convincing capability to inflict unacceptable damage on an attacker."[4] The levels of

unacceptable damage were eventually calculated as the destruction of 20 to 25 percent of the Soviet population and half of its industry. The second objective was "damage limitation," a series of measures to protect the American population and industry in the event of nuclear war.[5] These two objectives provided the yardstick for determining the adequacy of both offensive and defensive strategic nuclear programs.

In the late 1960s, the Soviet Union launched a substantial nuclear weapons building program and by the last years of the decade posed a serious challenge to American strategic dominance. Although the United States did not substantially increase its number of delivery vehicles–bombers and missiles–it did develop new technologies to counter the Soviet buildup. The first of these new technologies was the multiple independently targeted re-entry vehicle (MIRV). Instead of one warhead, an ICBM by 1966 could carry several, each of which could be directed to a separate specific target. MIRVs substantially increased the number of warheads that the force of Minuteman missiles could deliver.[6] The second technology—the antiballistic missile or ABM—was more controversial than the first. Development of the ABM, a missile designed to intercept and destroy an incoming enemy ICBM, had begun during the Eisenhower years but received increased attention in 1964 when it appeared that the Soviets were deploying an operational ABM around Moscow.[7] An extensive Russian ABM system could have seriously reduced America's ability to inflict assured levels of destruction, and the lack of our own ABM system could have increased the amount of damage that the United States would suffer under a nuclear attack. The question of whether to deploy an American ABM system produced a major public and congressional debate in the late 1960s and brought the issues of strategic nuclear doctrine into the limelight.[8]

Because the Soviet strategic weapons inventory was increasing, American military planners had to determine the adequacy of American nuclear forces in terms of the two objectives, assured destruction and damage limitation. According to John J. Taylor, ESSG did a series of four strategic weapons studies in order to "give the Army some background for positions in the Joint Staff."[9] Although most strategic weapons were part of the Air Force and Navy, the Army still participated in decisions about weapons systems and targeting in the Joint arena: "At this time the Army Staff was still leaning on us to conduct a lot of these analytical studies."[10] The four strategic nuclear studies included broad analyses of America's requirements for strategic offensive delivery systems, a comparison of two proposed bombers and a proposed missile, and an investigation of the requirements for nuclear bombs.[11] One study became a part of the Joint Strategic Objectives Plan (JSOP).[12]

In this series of studies ESSG held the same position that it had adopted in the late 1950s. Although doctrine and technology had changed,

the group felt that America's major strategic weapon should be the ICBM, and not the manned bomber: "We still have too many bombers and too few missiles in our programmed strategic offensive forces."[13] This position was based on the comparison of "anticipated performance characteristics of weapon systems and the physical characteristic of projected targets."[14] The major weapons systems' characteristics that ESSG considered important were prelaunch survivability, reliability, speed in reaching the target, and accuracy.[15] Among the characteristics of targets, time-sensitivity and hardness were the most important. Certain targets, such as missile launching sites or bomber bases, would have to be struck quickly. This action was critical to achieving the damage-limiting objective that was "to destroy the enemy strategic offensive capability."[16] Target hardness, on the other hand, dictated the yield and accuracy of the weapon. In its strategic forces analyses, ESSG categorized enemy targets according to their time-sensitivity and their hardness and then determined which delivery system would be most effective in attacking the various target categories.

The interaction of weapons systems and target characteristics led ESSG to emphasize the disadvantages of bombers:

> Slow response and low pre-launch survivability in retaliation restrict the contribution of manned bombers in general nuclear war from a targeting standpoint. Slow response time prevents CONUS based aircraft from reaching target areas in sufficient time to destroy enemy nuclear delivery forces before launch. Low pre-launch survivability will limit their employment against targets in the assured destruction task. The inability of the aircraft to ride out an enemy attack denies the capability to retaliate at times of our own choice. Ballistic missiles, in comparison, are highly responsive systems capable of sustained survivability.[17]

Slow response time and low prelaunch survivability in addition to their vulnerability to Soviet air defenses made bombers unsuited for most of the tasks of assured destruction and damage limiting.

Although ESSG emphasized the weaknesses of bombers, it did concede that a small bomber force could fulfill certain missions: "First it will require the enemy to maintain and improve costly air defenses, including interceptors and SAMs [surface-to-air missiles]. Second, it will provide a margin of insurance against an unexpected degradation of U.S. ballistic missiles."[18] This degradation could result from improvements in Soviet ABMs or anti-submarine warfare. Except for these essentially backup roles, ESSG concluded that "it is difficult to describe targeting roles for strategic bombers in the mid-1970s."[19]

The ESSG studies warned, however, that strategic forces analysis was particularly difficult in the late 1960s because it was hard to project how long the Soviet missile buildup would continue and how many new ICBMs the Soviet Union would have by the mid-1970s. Furthermore, the

new technologies of the late 1960s complicated predictions. If the Soviets developed and deployed MIRVs, these would represent an added threat to the survivability of America's land-based ICBMs. In addition, planners could not predict the size or the effectiveness of the Soviet ABM network.[20] All of these factors threatened America's position of nuclear superiority and emphasized the need for careful nuclear weapons planning.

The weapon that caused the greatest concern in the mid-1960s was the new ABM—the Goulash—which the Soviets first displayed on 7 November 1964. Although American intelligence knew that the Russians had been testing ABMs since 1960, the second generation, high-altitude, long-range Goulash came as a surprise and appeared to pose a substantial threat to American ICBMs. Mr. Taylor described the Goulash as "an area defense weapon designed to intercept missiles hundreds of miles out in the exoatmosphere. It used X-ray as the primary kill mechanism."[21] In a study requested by the Deputy Chief of Staff for Operations (DCSOPS) and published in June 1965, ESSG identified the vulnerabilities of American ICBMs and recommended measures to counter the Goulash threat.[22] According to Mr. Taylor, "appropriate steps were then taken by the designers of our missiles to introduce the necessary hardening in our missiles to protect them."[23] By the late 1960s the Soviet ABM program slowed and, with the American countermeasures, became less threatening.

The ABM was not the only threat to American strategic offensive forces. John Taylor noted that the growing Soviet stockpile included "more accurate weapons and weapons with higher yields. No longer was the Minuteman in a 300-psi silo invulnerable to the Soviet forces."[24] Improvements in Soviet ICBM technology could, it was feared, give them the ability to destroy a large part of the American silo-based ICBM force before it could be launched. The Air Force proposed to counter this threat by putting the Minuteman missile in silos in very hard rock, "which would increase their survivability by an order of magnitude estimated to be from 3,000 to 5,000 psi hardness."[25] Unfortunately, the Air Force proposal had, according to Mr. Taylor, "a lot of holes":

> Most of our hard rock was way down in the Arizona area and [this location] would not enable the missiles to reach their targets. Somehow the Air Force had never taken a string and a map and calculated how far 5,000 miles would take the missiles. But as I recall, none of the missiles would have been able to reach targets in China. Certainly we would have been limited in targeting to the northern reaches of the Soviet Union.[26]

ESSG analysts reported their conclusions to the Chief of Staff of the Army, General Harold K. Johnson, and DCSOPS, who asked that the conclusions be written up immediately so that they could take them to the Joint Staff. Mr. Taylor recalled that ESSG never heard any more about the Air Force proposal. Although this study was significant, it was not costly. "It was

a paper done by me," Mr. Taylor added, "and an assistant during a three-week period. It probably cost the government less than $1,000 at that time. Yet it had a very high impact."[27] In 1968, at least, hard rock was not the solution to Minuteman vulnerability.

In the late 1960s, ESSG continued its analyses of strategic nuclear strike plans. In 1966 the organization examined the Single Integrated Operations Plan (SIOP) from the Army perspective and again found that the strike plan showed too little concern for post-attack ground operations. The 1966 study reexamined the categories of targets that the group felt could assist land force operations and revised substantially the target list recommended in 1963.[28] ESSG concluded its strategic nuclear studies for the period in 1969 by examining for the Army some of the options being proposed by the strategic arms limitations talks (SALT).[29] ESSG's long experience in the field continued to make it a focal point for Army studies in strategic nuclear weapons, and the group's strategic weapons studies served as a foundation for many of the Army's positions within the Joint Staff.

In the late 1960s the growth of the Soviet nuclear arsenal and the development of MIRVs and ABMs threatened the strategic nuclear preponderance of the United States. These new developments made strategic forces analysis more difficult, but ESSG continued to believe that missiles were superior to manned bombers. The unexpected appearance of a Soviet ABM, and an Air Force proposal for protecting American missiles, prompted some of the group's most significant strategic nuclear work during this period. The group on behalf of the Army continued to urge a greater role for strategic weapons in land operations in a European war. The last major period of the organization's strategic nuclear studies saw it pursuing topics that had first appeared in the 1950s and topics that involved knowledge of the latest developments in strategic weapons technology.

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While tactical nuclear weapons were less dramatic than the strategic ones, major questions remained about their employment and their place in American strategy. Because these smaller nuclear weapons had never been used in war, the Army relied on study and analysis to determine their future role and significance. Although the Kennedy administration had attempted to deemphasize tactical nuclear weapons, they remained an important element in America's weapons stockpile.

The employment of atomic demolition munitions (ADMs) had been one of the first areas of ESSG study in the field of nuclear weapons, and the organization continued ADM studies in the late 1960s. Although ADMs had been available since the early 1950s, plans for their use were still beset by major doctrinal and technical problems. ESSG felt that the program had been "impaired by the size, complexity and variety of munitions as well as

their technical limitations. The training and retention of ADM specialists, security problems, and particularly command and control procedures have combined to harass commanders."[30] Many of the technical problems, which ESSG and others had previously pointed out, had been solved. However, the major difficulty lay in the fact that the ADM was a nuclear weapon, even though its function was to create the same kind of barrier obstacles as conventional weapons: "ADMs differ from nuclear weapons in that they may be generally regarded as defensive devices of relatively small yield which are precisely emplaced on the soil of the defender to delay aggressive incursions. Despite this difference, political considerations and the radioactive fallout are produced for ADMs as for other nuclear weapons."[31] Because ADMs were nuclear weapons, their use required authorization from high officials. Possible delays in the authorization had "led to uncertainty on the part of frontline commanders as to whether plans for early use of nuclear demolitions are practical, since there is the possibility that the enemy could overrun our defenses before release authority is available."[32] Behind the fears about delays in authorization lay the broader problems of escalation from tactical to strategic nuclear war.

The series of ESSG studies that examined these problems in 1965 grew out of conversations in late 1964 between McNamara and the West German Defense Minister. The two leaders outlined several military issues of mutual concern and established both American and German study groups to investigate these areas. The Chief of Staff of the Army, General Earle G. Wheeler, assigned the ADM topic to DCSOPS, who in turn asked ESSG to do the study.[33] Although the two study groups conferred, they produced separate and dissimilar studies, and the ESSG study was modified somewhat before it was released as a DCSOPS document in July 1965.[34]

Once again, the group concluded that ADMs had definite practical advantages over conventional explosives. ADMs could be emplaced more rapidly than conventional explosives, they were much lighter, and they produced much more damage per ton of explosives. In short, all logistical considerations favored their use.[35] In spite of these advantages, Army commanders hesitated to plan for ADM use because the authorization or release procedures were so cumbersome and time-consuming. Using quick war gaming techniques, ESSG demonstrated that delays in release in the face of a major Soviet attack quickly reduced the value of ADMs. Release procedures were elaborate, however, because of the fear that American use of this tactical nuclear weapon could begin the process of escalation that might lead to a massive thermonuclear war. Although the ESSG study admitted that the problem of escalation was complex, it argued that the dangers were less severe because ADMs would be detonated on friendly, not enemy, soil, and because they were intended to produce obstacles, not casualties.[36] The munitions did cause fallout, but it could be carefully controlled and minimized. In addition, the studies maintained that a clearly articulated

NATO policy of ADM use could help deter Soviet conventional attack.[37] In ESSG's opinion the need for quick and early use of ADMs warranted "a comprehensive review and analysis of ADM release procedures."[38]

Although ESSG continued to believe that nuclear demolitions could be important weapons, the group cautioned against indiscriminate use. Two studies begun in 1967 analyzed the potential effectiveness of ADMs and arrived at different conclusions for two theaters.[39] In Korea, the mountainous terrain and the expectation of a conventional attack led the group to conclude that ADMs could effectively delay the enemy advance. But in Southeast Asia, the terrain and the anticipation that a future war would also be a guerrilla conflict characterized by the absence of clearly defined front lines meant that ADMs could serve little useful purpose there. While ADMs had certain definite military advantages, these were only appropriate for specific tasks and situations. Yet even precise calculations of their tactical military usefulness still left the complex problems of release and escalation unsolved.

The employment of nuclear demolitions was only one aspect of the tactical nuclear war studies that ESSG had done for almost two decades. In 1965 the organization completed its third substudy for Project OREGON TRAIL; two others had been published in the previous year.[40] The purpose of OREGON TRAIL was "to develop a rationale for tactical nuclear warfare."[41] In the third study ESSG examined operations and organization in the communications zone (COMMZ), in which the primary mission was providing support to the combat zone. Since casualties in the COMMZ from nuclear strikes were expected to be heavy on both sides, "the margin of victory is on the side which can be provided minimum essential logistic support for the longest period and can maintain an organized force on the battlefield."[42] Crucial to maintaining this organized force would be the replacement of damaged equipment, especially in the period prior to resupply by sea. The three major sources of equipment during this period would be recovery of usable equipment from units rendered ineffective by the attack, prestocked equipment, and airlift from the United States.[43] Because salvage and airlift might be unreliable sources, the group recommended that equipment and supplies be prestocked in a number of small, scattered depots that would be less vulnerable targets. Because this principle of logistical operations ran counter to the highly centralized supply system envisioned for conventional war, it required the Army to consider adopting different contingency measures for tactical nuclear war.[44]

In the late 1960s the Army still struggled with the problems of tactical nuclear warfare. While the technology of this warfare had gradually improved since the 1950s, the question of when and where to use weapons such as the ADM remained, and the uncertainties about escalation influenced all of the tactical issues. Predicting the pattern of actions that would lead to escalation, like predicting the best way to organize logistics in

the devastated COMMZ, was complicated even more by the fact that no tactical nuclear war had ever been fought. Because empirical experience was minimal, the subject of tactical nuclear warfare necessarily provoked a disproportionate degree of study, especially when the Army would bear the brunt of fighting it.

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With the growth of Soviet nuclear power in the late 1950s and early 1960s, the United States became concerned not only with offensive nuclear weapons, but also with the defense of the United States from a Russian nuclear attack. Although in McNamara's strategy, assured destruction gradually became more important than damage limitation, the early 1960s had seen more vigorous interest in preparing America for the possibility of nuclear devastation. Adequate defensive preparations required an understanding of the effects of nuclear attacks, but this kind of analysis was resisted. As Major General Robert R. Ploger observed, "the prevailing view was that a nuclear war, once begun, would be over in a few hours or, at most, days. There was little interest in studying the after effects. Popular concepts of the aftermath were of a devastated, dead world."[45] Because of increased interest in damage limitation, however, "military planners have responded to the need for more critical analysis of the implications of nuclear war."[46] ESSG was among the leaders in responding to this need.

ESSG had created a Vulnerability Analysis Branch in 1960, and one of the earliest extensive studies of the effects of a nuclear attack on the United States had been PAMUSA-63 (Post-Attack Mobilization of the United States Army), published in 1961.[47] In the fall of 1964, ESSG began another, broader study of the post-attack environment for the Army Survival Measures Plan (ASMP), which had as "its primary purpose the assured survival from strategic nuclear attack of an adequate army residual to carry out post-attack missions in pursuit of national objectives."[48] The WORLDPANE study, completed in March 1965, determined "the probable post-attack environment of the major world powers resulting from nuclear attacks considered in the most recent studies and war games."[49] The study also appraised the capability of the national economy to support military operations and examined possible post-attack balances of power. WORLDPANE studied 15 nations drawn from all political camps and calculated the effects of hypothetical nuclear exchanges postulated in other studies, including PAMUSA-63. In essence, WORLDPANE drew together much of the data from existing vulnerability studies.

In its conclusions, ESSG ran counter to the prevailing view that the aftermath of nuclear war would be a "devastated, dead world." Although the study did not minimize the possibility of enormous devastation and destruction, it maintained that "the world powers can survive a general

nuclear exchange and retain their national viability."[50] The United States and the Soviet Union would suffer the heaviest damage with their populations and industries reduced to levels equivalent to periods earlier in their history, but both would remain at levels reached in the 20th century. The other countries studied would for the most part suffer substantially less damage. Yet the power balance in the post-attack world would be close, indicating "that the United States must take whatever actions are necessary to insure that Western Europe and Japan remain in the Free World sphere."[51] Because the destruction would be less than paralytic, WORLDPANE assumed that the war would go on and that "the U.S. will have a population and industrial residual capability in the post-attack period sufficient to support essential military operations."[52]

As a result of its work on WORLDPANE and its examination of other related studies, ESSG began to analyze the logic in the methods of vulnerability analysis and found some of these methods inadequate. The most serious difficulties came in the measures of the damage from nuclear attacks: "An attack against retaliatory forces may be measured adequately by a straightforward assessment of damage to weapons systems and their launching and control facilities. In the case of attack against a developed economy, such an assessment of physical damage and gross fatalities may not provide an adequate measure of the total effect of an attack. This occurs because of industries' dependence upon one another and the skills and disciplines of the labor force, and vice versa."[53] While damage might be great, it would not be spread equally throughout a nation: "The fundamental shortcoming of the use of pure population fatalities or 'brick and mortar' damage to industry is that they assume all elements are of *equal value* to survival and recovery activities."[54] The destruction of key occupational groups or critical industrial facilities might result in damage to the post-attack economy that was disproportionate to the gross national damage figures.

The methodology that ESSG proposed was to divide the United States into smaller, discrete areas that would suffer varying degrees of nuclear damage. Because nuclear attacks would most likely hit some areas harder than others, the country after the attack would consist of "islands of destruction surrounded by huge areas of survival."[55] Even within the islands of destruction, it would be necessary to calculate the potential survival of different occupational groups and industries: "The industrial part of the analysis should identify critical industries, their associated production capacities, and the relationship existing between the industries within the area. The population base must identify occupations and their respective association with the area's industries."[56] With this detailed information, the analysts could obtain a more accurate picture of the capacities of the surviving local economies, both damaged and undamaged. Compiling

this local information would better forecast the national economic and military potential for survival.

Although this approach seemed conceptually sound, ESSG found that accumulating the necessary data was difficult. The group asked the Bureau of the Census for its projections but discovered that the agency could not make the appropriate data available. Existing census data were not suitable, because ESSG studies projected a number of years into the future.[57] Using census data from 1960, for example, was hardly helpful when calculating the effects of a nuclear attack in 1975. As a result, the ESSG analysts were forced to make their own population and industry projections. According to Lloyd Addington, an analyst who worked on the study, these projections were "simple and crude" by present-day standards, but in the late 1960s were considered to be a great advance over the old techniques used in calculating nuclear damage.[58] In June 1966, ESSG published *United States Labor Force—1975*, which estimated the number of workers in each of 116 skills for the 100 Standard Metropolitan Statistical Areas (SMSAs).[59] A "remainder of state" category showed the numbers of workers in each skill outside the SMSAs. The following year the group published *United States Industry—1975*, which estimated the "total sales" for each of 78 specific industries for each of the same geographic areas used in the earlier study.[60] In making these estimates, the analysts used a number of sources, including material from the Census, the Bureau of Labor Statistics, and the Rand Corporation. Although most of the projections were based on extensions of historical data, the studies did discern certain trends that were not widely recognized in the late 1960s, particularly the movement of population into the West and South or the "Sun Belt."[61] All of these data were essential for determining "what products surviving industry could produce" and "whether sufficient appropriate skilled labor would be available to operate the surviving facilities."[62]

Using the data base that it had created, ESSG in January 1967 published its largest and most comprehensive study of American society after a nuclear attack. *Post-Attack Viability of the United States—1975 (PAVUS-75)* sought "to predict the capability of the United States economy to recover from a strategic nuclear attack in 1975."[63] The study had taken a year and a half. Although PAVUS-75 evaluated the impact of several hypothetical nuclear attacks of varying severity, the most damaging postulated attack perhaps best illustrates the methodology and conclusions of the study.

In the most devastating attack, enemy nuclear weapons would strike all large- and medium-sized American cities and major military targets, producing 100 million fatalities and destroying almost half of the country's economy. The blast and thermal effects of this devastating attack would affect approximately 20 percent of American counties, and lethal fallout

would cover another 30 to 40 percent of the counties.[64] Somewhat less than half the country would escape the effects of blast, heat, and fallout, leaving "islands of complete desolation surrounded by large areas of no physical damage."[65] These undamaged areas would contain only about 20 percent of America's population and industry. But if local governments, which should remain intact, reacted quickly and effectively, "these unscathed resources would be a tremendous potential asset which could serve as the backbone of the nation for the first few weeks of a post-attack period."[66]

In the damaged areas, the first priority would be the enormous job of rescue and cleanup, but PAVUS-75 estimated that the surviving construction industry and to a lesser extent the military engineers would have enough equipment and manpower to accomplish the task. The next priority would be returning the economy to production, and while estimating the surviving physical industrial plant was relatively easy, General Ploger, who wrote an article based on the study, explained that

> capacity in itself is not sufficient for the prediction of post-attack production possibilities because individual industries are not self-sufficient. One of the most difficult problems is the calculation of how much the production of one industry would be reduced because it could not obtain materials or services from another industry.[67]

Using input-output analysis, ESSG determined that post-attack production would be approximately 20 percent less than the surviving physical plant could have produced under normal circumstances (see figure 21).

PRODUCTIVE CAPABILITY OF RESIDUAL INDUSTRY—1975

	Gross National Product*		
Attack	1975 Pre-Attack	Surviving Physical Plant	Capability After Interindustry Considerations
I	905	610	490
II	905	605	480
III	905	740	660

*In billions of 1960 U.S. dollars.

Figure 21

In addition to decreased capacity of surviving industry, the United States would also face a shortage of labor. Once again the total surviving labor force would be too gross a measure, especially in the event of shortages in certain skilled labor groups. Although the labor force would sustain huge losses, ESSG concluded that it could staff the surviving industrial plant if certain measures, like those followed in England during World War II, were used. These measures included a longer work week and employing women and increased numbers of youths in the 14- to 17-year-old age bracket. This intensive use of surviving labor would allow the remaining population to reach 90 percent of its pre-attack labor capability.[68] Thus while both the pre-attack population and industry would be greatly reduced, it would still be capable of substantial output.

PAVUS-75 assumed that after the attack the United States would not only rebuild but would also continue the war. In spite of the enormous population loss, there would still be 11 million men in the 18- to 35-year-old age cohort, and based on World War II rates of mobilization, the study estimated that the United States could induct 4.5 million into the military forces. Would the post-attack economy, however, be able to support this military effort while providing the survivors with an adequate standard of living? ESSG calculated that if the economy were geared to provide a 1940s standard of living to the smaller surviving population, then 59 percent of the post-attack economy or $300 billion of productive effort could be devoted to reconstruction and defense. In comparative terms, this amount was almost twice that spent on the war in 1944, the peak year of spending in World War II.[69] According to Mr. Addington, the United States would still be twice as powerful as any other nation.[70] "With resources of this magnitude," General Ploger wrote, "the United States would still possess tremendous national potential."[71]

Although PAVUS-75 was impressive both for its findings and its methodology, military planners in the field readily acknowledged its results were tentative. Actual experience with nuclear weapons was limited to two detonations in World War II and a series of single atomic test explosions. General Ploger acknowledged that "this experience has provided extensive data on weapons effects but little of use concerning survival and recovery on a large scale."[72] In the absence of empirical data, the studies of post-attack recovery were necessarily based on a series of assumptions that could vary widely from study to study and result in findings that were substantially different. Beyond all the conclusions about population and industry survival lay the human psychological factors that would determine the reaction to such horrendous and devastating destruction. Much would depend on how individuals and institutions such as governments responded to the enormous dislocation and awesome tasks posed by a nuclear holocaust. While PAVUS-75 and others like it were based on detailed information and rigorous analysis, they remained "educated guesses."[73]

In addition to broad studies of nationwide survival and recovery, ESSG also did more specific work on Army survival. The Army Survival Measures Plan (ASMP), initiated in 1963, included a "five-year plan for providing the Army with adequate passive defenses from nuclear attack."[74] The ASMP required each Army commander to draw up detailed plans based on specific guidance to increase the survivability of personnel on his installation. In a series of three studies, ESSG analyzed these plans and proposed measures to protect Army personnel from nuclear attack.[75] One basic task of the ASMP was "the determination of what units and materiel resources must survive, followed by the selection of the least expensive measures that would ensure the desired degree of survival."[76] The studies calculated the effects of a number of hypothetical nuclear attacks against Army installations that had taken various measures designed primarily to protect personnel from fallout. On the basis of these analyses, ESSG looked for the cheapest and most effective methods to ensure the survival of key Army elements.

Because the ASMP emphasized passive defense, most of the recommended measures involved fallout shelters and dispersal of personnel. Although none of the measures were dramatic, ESSG estimated in 1966 that by spending less than $100 per person, the Army could double the probability of survival.[77] The studies also served as background for Army requests for funds from the Secretary of Defense. As a part of its involvement in the ASMP, ESSG wrote three Department of the Army pamphlets that explained the program to regular Army and reserve units.[78] Although the program continued to function in the late 1960s, it received only modest funding from McNamara, who was now deemphasizing damage limitation. In 1970, ESSG concluded that because there had been no major changes in funding or approach since 1969, a fourth yearly study of the ASMP was not needed.[79]

Whatever measures were taken to protect the Army, military installations were expected to be prime targets for nuclear attacks. In 1967 the JCS ordered the services to prepare procedures for assessing damage and determining surviving strength during and after a strategic nuclear attack. The Army assigned this responsibility to the Chief of Engineers, who asked ESSG to design a system. In August 1969 the group published a study that proposed a series of measures that would monitor the damage as it occurred and relay this information to higher military authorities.[80] Later in the 1970s ESSG did more studies of the military damage assessment system.

Although the destruction that would be wrought by a thermonuclear war was horrible even in the mildest scenarios, there was a growing feeling in the Defense Department in the 1960s that the questions of survival needed more careful study. If the massive initial exchange would not obliterate the United States, how many people would survive and what would their capabilities be? Although these questions were difficult to

answer, ESSG tried to provide reasonable answers based on the best data and the most plausible assumptions available. In the latter part of the decade, Secretary McNamara and the Defense Department for a number of reasons came to place less emphasis on damage limitation and survival and more emphasis on the inexorable horrors of the devastation that the assured destruction forces of both sides could produce. Although the interest in vulnerability and survival continued, the specter of mutual destruction dominated the strategic thought of the next decade.

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Although nuclear warfare remained one of ESSG's primary study areas in the late 1960s, the group became heavily involved in the major concern of the Army during the period—the war in Vietnam. ESSG had already published a series of studies in 1962 and 1963 on potential logistical problems for American military operations in the western Pacific. In 1965 most of ESSG's effort, whether in formal studies or quick reaction reports, focused on the military engineering and logistical problems caused by the rapid and often unanticipated buildup of American forces in Southeast Asia.

The heavy American military involvement began in March 1965 when two Marine battalions landed in South Vietnam with an explicit combat mission. But it was mid-summer before President Johnson ordered large numbers of Army ground combat troops into Southeast Asia.[81] Prior to that commitment, the Army staff needed to know the engineering and logistical problems a large American force might encounter in Vietnam. Because events occurred rapidly, the Chief of Staff of the Army, General Harold K. Johnson, wanted quick analyses and found that he could get them from ESSG.[82] In two studies completed in a matter of weeks and published in March and April, the group estimated the Engineer combat and construction tasks that would face corps forces either in northern South Vietnam or in central Vietnam in the Pleiku-Kontum area.[83] The estimates covered the entire range of Engineer requirements from roads, bridges, barriers, and Army airfields to ports, hospitals, petroleum distribution systems, and water supply. The studies, which were presented to high levels of the staff, concluded that both deployments would be difficult operations. Because ESSG had long experience in such analyses dating from the Department of the Army Strategic Logistic Studies (DA-SLs) and more recently the Force Planning Guides, it could often respond more rapidly than the Army staff. Although these quick reaction studies were not common in the group's history, they demonstrated that the organization could draw on its planning experience to respond to more immediate and pressing problems.

By the fall of 1965, ESSG was working to avoid some of the prob-

lems that had appeared in the rapid Vietnam buildup of that year. In October it published a study for the Chief of Engineers "to evaluate what advance construction should be undertaken in Thailand to prepare for a force buildup in that country."[84] The objective of the study was "to preclude the necessity for a rapid buildup of facilities on a crash program basis such as occurred at Cam Ranh Bay, Republic of Vietnam, during the buildup of U.S. forces in the summer of 1965."[85] The study examined the ports, petroleum distribution system, airfields, railroads, and highways of Thailand; projected the requirements of a hypothetical corps force for all these facilities; and then devised a list of construction projects that could be undertaken prior to any troop deployment. Because the list was considerable, the study indicated projects that could reasonably be done by Army Engineers, others that should be handled by contractors, and estimated the costs of both. Even though a major commitment of American forces never materialized, the group was already trying to assimilate the lessons of Vietnam.

ESSG continued to do studies related to the buildup in Vietnam, but now these studies were concerned mainly with the problems involved in supplying large American forces in South Vietnam. In 1965, ESSG representatives went to Vietnam to develop the preliminary engineering design for ship-to-shore petroleum discharge systems and on-shore storage and distribution systems. In 1966 *Ports and Beaches, Southeast Asia* examined the existing and projected port facilities in South Vietnam and Thailand and compared them with "an estimate of the plausible maximum tactical deployments to be supported through the ports."[86] This type of port planning encompassed a large number of factors, including "the type of port operations envisioned, the channel and harbor conditions at the port site, the need for shore facilities, the discharge capacity of piers, wharves and slips, marine POL [petroleum, oils, lubricants] discharge facility requirements, the capability of the various LOC [line of communication] modes, and the construction effort and cost to provide the port facilities."[87] The detailed analysis of these factors for six potential ports filled three lengthy volumes.

Because the commitment of troops grew ever larger and Vietnam was located thousands of miles away, ESSG did two studies of potential "offshore" logistical bases that would be located outside of that turbulent country but close enough to provide effective support. The Deputy Chief of Staff for Logistics (DCSLOG) asked ESSG to determine the facilities required to support two different force levels in South Vietnam, the locations in the Western Pacific that could accommodate this base, the problems involved in acquiring base rights and real estate in the locations selected, and the time and expense involved in constructing the base. All potential locations were to be considered as substitutes or complements to the existing major base in Okinawa. ESSG concluded that although Okinawa was in-

adequate by itself and a new complementary base was technically feasible but costly, the diplomatic problems of obtaining base rights probably would preclude the immediate construction of a new offshore logistics base.[88]

Two years later the group again examined the feasibility of an offshore logistics base, but one that might be even more extensive, especially if Okinawa reverted to Japan. ESSG relied on the two earlier studies as models because these "were considered by the Army Staff to provide a basic pattern for developing an offshore logistics base."[89] Once again the group postulated the mission of this logistics base, and calculated the facilities it would require and its cost. Because the Army wanted to locate the base in the United States trust territories in the South Pacific, the diplomatic and political problems of the earlier studies were largely avoided. But the base to be constructed in the mid-1970s would still be expensive. Although the study concluded that there was "no question as to the technical feasibility of siting an operation and logistic base in the Trust Territory," it cautioned that there might be "better ways to solve the Army's offshore logistic support requirement. For example, increased strategic mobility acquired from improved transportation means (C-5A aircraft and FDL [fast deployment logistic] ships) may significantly reduce the logistic mission considered in this analysis."[90] ESSG's series of studies in strategic mobility had led to the conclusion that projected techniques of long-distance logistics support should be considered as alternatives to the construction of a fixed, overseas logistics base.

Although the United States did not build an offshore logistics base in the Western Pacific, these three studies have been cited as "classic examples of what the study business is really all about."[91] According to George Orrell, "studies are designed to illuminate issues for decisionmakers. In each of these cases, these documents became the only available resource that [the Army] could turn to in order to see what these bases would look like, how big they would be, what they would cost, and where they would be located."[92] That the bases were not built was due at least partially to the political, military, and economic drawbacks outlined in the ESSG studies.

While developing and consolidating an American logistical system was an important concern of military planners in the mid-1960s, the enemy's logistical network was also an important factor in the widening war in Southeast Asia. Although the American troop buildup continued and the bombing of North Vietnam intensified, American and South Vietnamese forces did not gain a decisive victory. The ability of North Vietnam to transport men and supplies to the south in spite of all efforts to halt this flow presented a perennial problem to American strategists. By the spring of 1966, Secretary McNamara, in casting around for measures to cut off this movement, came upon the idea of an anti-infiltration barrier between North and South Vietnam.[93] In the summer of 1966, the Jason Division, an

ad hoc meeting of scientists and technicians under the auspices of the Institute for Defense Analysis, explored the feasibility of building such a barrier as an alternative to bombing, which the Jason Division felt was ineffectual.[94]

Throughout the summer and fall of 1966, a great deal of effort in the Army and the Defense Department went to finding ways to build an effective barrier. Because ESSG had long experience in planning barrier systems, the Army staff asked it to join in the sometimes frantic search. At one point the group even explored the possibility of planting poisonous or thorny plants across the routes, but research conducted with an agricultural experimentation agency proved that this approach was not feasible.[95]

In October 1966, ESSG produced an extensive plan for a more conventional barrier.[96] The study began by analyzing all the available intelligence information on North Vietnamese infiltration routes and methods and examining the geographic features of the land borders of South Vietnam in a terrain analysis similar to those that had always accompanied ESSG's barrier studies. Using this basic information, the group devised three alternative border control systems for each of three different types of terrain. These systems employed conventional barrier techniques such as wire, fences, ditches, and minefields and new techniques such as sensing devices that detect human movement (see figures 22 and 23). Because a static barrier would not be effective alone, the study estimated the numbers of troops necessary to support the border control system and prevent large intrusions. ESSG then estimated the cost and effectiveness of each alternative system and selected the one that seemed most suitable for sealing off the entire 1,400-mile land border of South Vietnam. Although ESSG did not recommend constructing this system, especially since it would be very expensive, it did warn that "a partial land border control system that can be bypassed probably will be ineffective."[97] McNamara eventually established a special group to study infiltration, and the study, as well as an ESSG analyst, became part of that effort.[98] In 1967 construction of the so-called "McNamara Line" began, but it was never completed and never stopped infiltration into South Vietnam.[99]

The intractable problem of infiltration continued to preoccupy the Defense Department, and in November 1967 McNamara initiated a more extensive study relating to the problem. The objective of this study was "a detailed analysis of the potential line of communication (LOC) that could be used by an enemy invading Southeast Asia and South Korea."[100] McNamara directed the study to consider "the degree to which the lines of communication could be improved in wartime, and the extent to which various degrees of damage to particular lines would affect the overall capacity of the LOC."[101] The Secretary also asked ESSG to do the study: "I am aware of the excellent work done by the Army Engineers Strategic Study Group [sic] on a similar study concerning the European theater. I

BORDER CONTROL STRUCTURES I

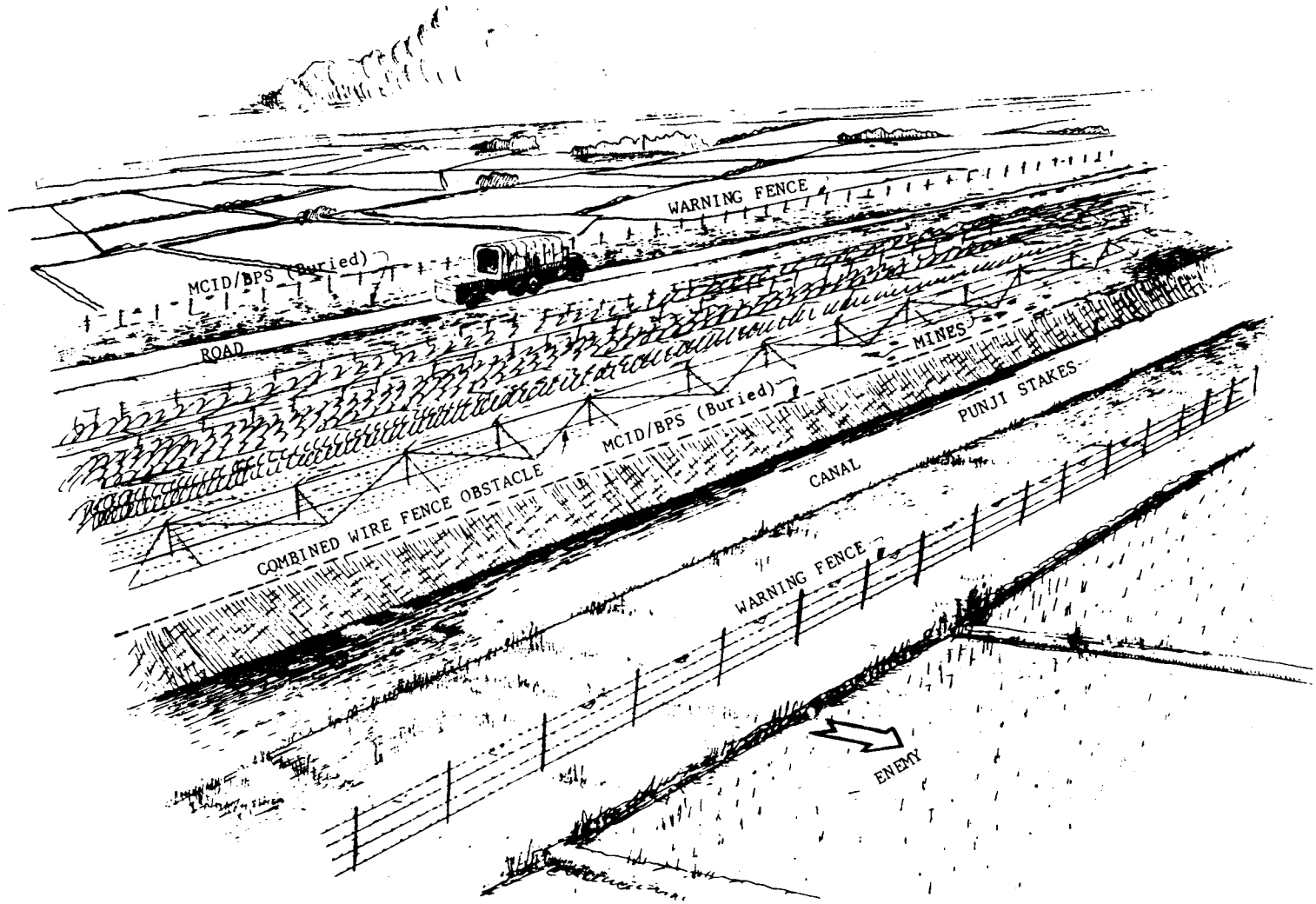

Figure 22

BORDER CONTROL STRUCTURES II

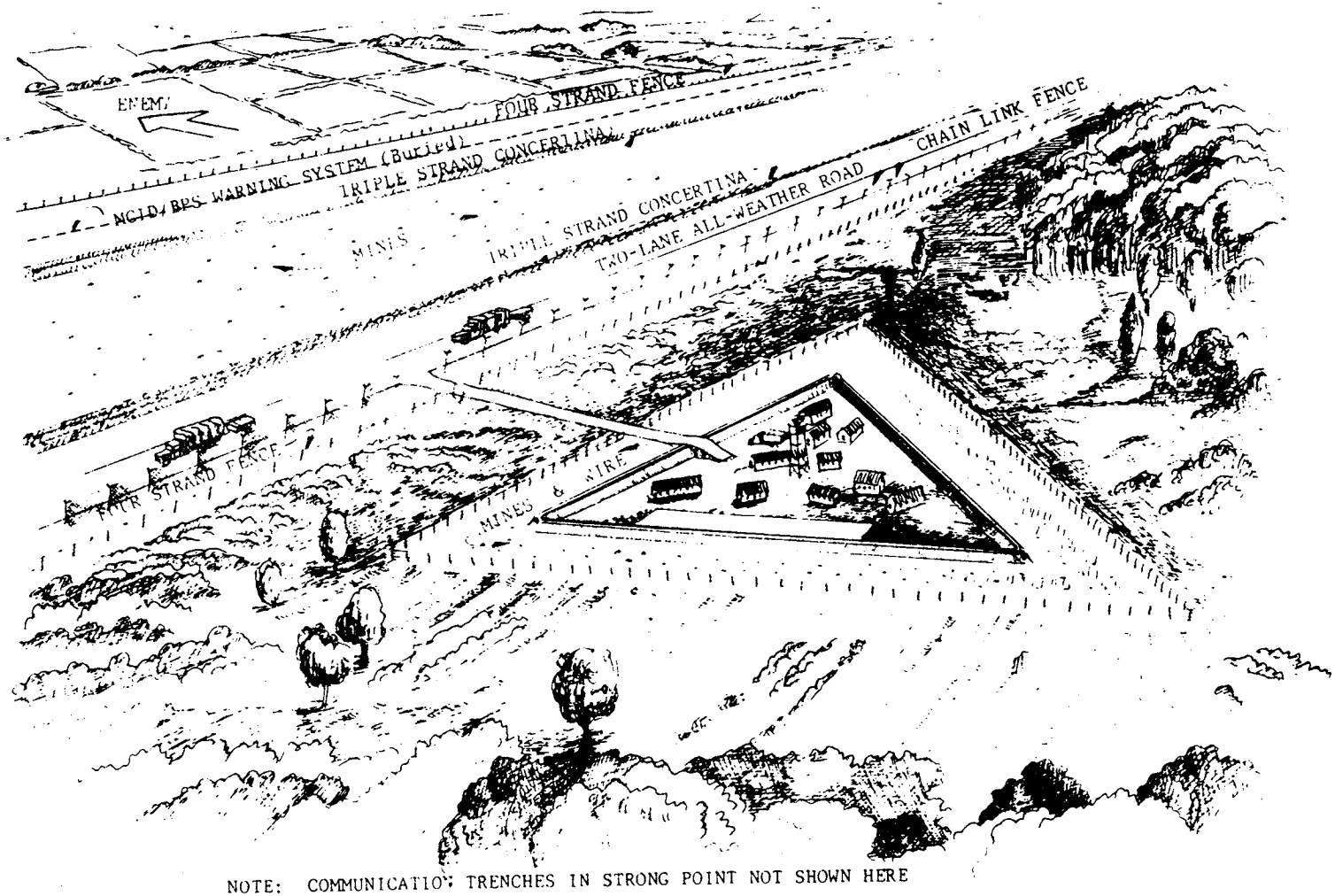

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Figure 23

would prefer that this group conduct the study in order to utilize its logistical and construction engineering skills in this extremely detailed technical analysis."[102]

The Army staff forwarded McNamara's order to ESSG through DCSOPS, and in early December, Colonel John C. Coyne, commander of ESSG, responded that the questions posed in the Secretary's request would require extensive investigation, especially since the information available on the effects of bombing infiltration routes was so inconclusive:

> DIA [Defense Intelligence Agency] representatives advise that to date they have been unable to correlate adequately interdiction campaigns and LOC degradation even in the present "real world" conditions of Vietnam. Many North Vietnamese LOCs have a greater capacity now than prior to the initiation of the U.S. interdiction campaign. In other places, LOC capacities have degraded even in the absence of interdiction.[103]

Because of the many difficult problems to tackle, Colonel Coyne responded that it would be impossible for ESSG to produce a complete study quickly: "In essence, the basic problem of determining the potential impact of interdiction on Chinese force levels supportable in SEA [Southeast Asia] is dependent for solution on a methodology which permits a reasonable assessment of the effectiveness of interdiction. Such a methodology does not exist and appears infeasible of development by February 1968."[104] Colonel Coyne then recommended a two-phased study. The first phase would "evaluate methods for estimating LOC capacities" and the second would "develop and test an empirically based procedure to estimate the effects of LOC interdiction on enemy operation."[105] When the Secretary accepted this approach, ESSG began work on a series of studies and reports on lines of communication.

In March 1968 the group completed the first phase, known as the CAPLOC (Capacities of Lines of Communications) study.[106] CAPLOC evaluated the various measures used within the Defense community to estimate the capacity of lines of communication. These measures drew largely on the experiences of World War II and Korea. While they produced satisfactory results when estimating the capacity of railroads, inland waterways, and trails, they varied widely in approach and conclusions when estimating the transport capacity of roads, especially primitive roads. ESSG concluded that this variation resulted from the fact that "none of the methods have a basis in either documented operational performance or field tests extensive enough to be convincing."[107] Because roads were the primary routes used to infiltrate supplies into South Vietnam, this lack of agreement on estimating methods was a serious problem.

In September 1968, ESSG and the Defense Intelligence Agency (DIA) sponsored a symposium on the problem.[108] In his opening remarks to the symposium, Major General Robert R. Ploger, Director of Topogra-

phy and Military Engineering in the Office of the Chief of Engineers, explained why the problem of estimating road capacity was considered critical in Southeast Asia, not only for future contingencies, but also for the present war:

> One of the most difficult areas in the planning sphere involves the matter of determining realistic potential enemy threat in a given region. Sound planning evolves from good threat estimates, which in turn are made in the light of the best intelligence. An enemy's ability to deploy and support forces is of paramount interest in determining threat estimates. His lines of communication and his ability to use these LOCs in support of combat operations must be analyzed accurately. In underdeveloped countries, as in large areas of Southeast Asia, the magnitude of the enemy threat under conditions of conventional war appears to be constrained by the enemy's ability to resupply his forces over land LOCs. Under such conditions, the magnitude of the threat is expressed very simply as: The Threat Equals the LOC Capacity Divided by the Force Consumption Rate. In underdeveloped countries the roadways constitute an important movement potential. Most of the roads are of poor quality. Unfortunately, our methods for estimating the capacity of these low class roadways appear to be imprecise. Therein lies our problem.[109]

Estimating road capacity was more than an obscure technical military problem; it was a key for determining force requirements in Southeast Asia.

The symposium, attended by specialists from a number of government agencies and private corporations, discussed the various factors involved in determining road capacity. Although some factors were clearly more important than others, it was difficult to formulate precise equations from factors as disparate as surface type and width; grades and curves; weather conditions; vehicle types, loads, and speeds; gap between vehicles; and a factor emphasized by ESSG, road maintenance (see figure 24). Given the variety of factors, the complexity of their interaction, and the fragmentary nature of historical and intelligence data, the group concluded that only a comprehensive test program could establish empirically valid methods of estimation.[110] Although the Defense Department initially approved this test program, it was never executed. Nonetheless, Assistant Secretary of Defense Alain Enthoven wrote in December 1968 that he would like "to acknowledge the high quality work and degree of cooperation provided by ESSG to date."[111]

Even in the absence of a test program, the group went on to conduct the second part of the analysis that Colonel Coyne had recommended, although the study was not published until two years after CAPLOC. The purpose of *Interdiction of Lines of Communication (INTLOC)* was "to develop an empirically based method for assessing the effects of an interdiction campaign on a logistics network."[112] Since empirical data were

PRIMARY CONSIDERATIONS IN ESTIMATING ROAD CAPACITIES

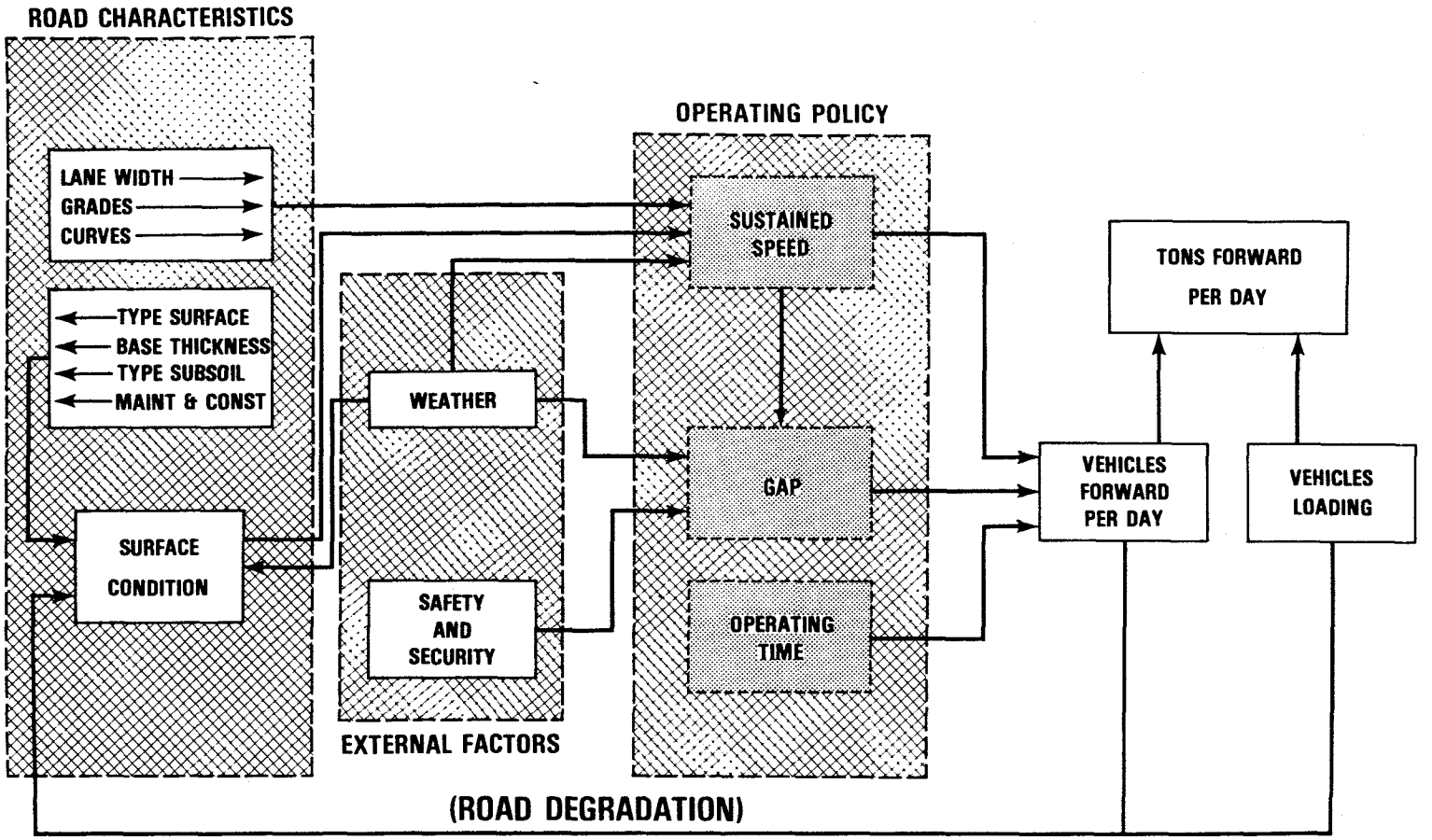

Figure 24

fragmentary and inadequate, ESSG decided to adapt a simulation model used by the Strategy and Tactics Analysis Group, but only after the model's developer, a contracting firm, had made changes specified by the group. The resulting INTLOC model analyzed the road, rail, and inland waterway transportation networks and made provisions for supply movement by trails. Because the model contained so many complex variables, it required a very large computer and extended computer time. In addition, INTLOC was very sensitive to the basic assumptions that had to be made before using the model.[113] Although INTLOC was not ideal, ESSG did the interdiction analyses that McNamara had originally requested for Southeast Asia and Korea. In spite of the extensive efforts of the American military to deal with it, infiltration remained a problem throughout the war.

Although most of ESSG's work relating to the war in Vietnam grew out of areas like military engineering or logistics in which the group had ample experience, several studies came from new and special problems posed by the war. In a highly classified study prepared for the Chief of Engineers in April 1967, the group summarized and reviewed "the scope and current status of Vietnam post-hostilities planning actions."[114] The study informed the Chief of Engineers of any aspects of these postwar plans that might affect the Engineers. Later in 1969, ESSG studied the damage to Army aircraft caused by enemy rocket and mortar fire to determine the Army's need for shelters for its aircraft in Vietnam. The idea had originated with the Air Force, which had launched an extensive shelter-building program. Using a straightforward cost-effectiveness approach, the group sent a team of analysts to Southeast Asia to sample the damage and repair costs, and then estimate the costs of constructing the shelters. The study concluded that damage to parked aircraft was only a very small proportion of the combat damage to aircraft, and it calculated that the shelter program would cost more than 30 times the damage sustained by parked aircraft in 1969.[115] In a letter to the commander of ESSG, the coordinator of Army Studies cited this study as an example of the group's valuable work: "The Vice Chief of Staff recommended against building shelters on the basis of the draft report. Hence the study may have saved up to $300 million."[116] In spite of the great demand for new ways of dealing with problems in Vietnam, not all of them were feasible or worthwhile.

In addition to these formal, published studies on Southeast Asia done in the late 1960s, ESSG did a number of quick reaction, unpublished papers described by a former analyst as "one- or two-day estimates of what engineer forces would be required to support this or that operation."[117] The Annual Historical Summary for 1969 called these papers "a continuing series of extensive, unscheduled short deadline projects applicable to engineer aspects of contemplated U.S. operations in Southeast Asia."[118] Another former analyst estimated that the group completed about 25 quick reaction studies or plans during the Vietnam period.[119] Generally these

short papers, like the formal studies, were based on ESSG's prior experience in a specific field.

The group did its formal studies and its quick reaction papers for the Army staff and the Department of the Army in Washington. The assessments supported the department's mission of force planning, design, and structuring. After these forces were raised, trained, and equipped, they were turned over to the commanders in the field.[120] "We did very little for Westmoreland or the people that succeeded him on things relevant to day-to-day, month-by-month operations in Vietnam," Mr. Orrell recalled, "but we did a lot of studies and quick reaction analysis for people in the Department of the Army and OSD [Office of the Secretary of Defense] who had to support the operations and anticipate what might be coming in the future."[121] The history of ESSG's involvement in the war in Vietnam was not a part of the combat operations and campaigns normally associated with a war. Instead it was a part of the history of planning and preparing for future contingencies usually associated with general staff work.

* * *

In the late 1960s ESSG continued the work begun earlier in the decade on general purpose forces. While some of the studies related specifically to the situation in Vietnam, most of them dealt with future requirements for forces and the means to transport and support them. These studies became a part of the Defense Department mid- and long-range planning system and addressed both regional and worldwide requirements. Although the nation was preoccupied with Vietnam, Army and Defense Department planners looked beyond the war in order to determine the forces needed to meet crises that could develop in the 1970s, how these forces would be structured and organized, and how the United States could deploy and support these forces in a variety of overseas situations. While the problems and the analytical effort were often familiar, the techniques and the results were marked improvements over earlier work both in ESSG and in other Defense Department agencies.[122]

Although the Army had devoted much attention to the requirements for general purpose forces in the early 1960s, it had paid less attention to strategic mobility, which President Kennedy had also emphasized as a part of his program to lessen American dependence on strategic nuclear weapons:

> We must have sea and airlift capable of moving our forces quickly and in large numbers to any part of the world. But even more importantly, we need the capability of deploying in any critical area at the appropriate time a force, which, combined with our Allies, is large enough to make clear our determination and ability to defend our rights at all costs and to meet all levels of aggressor pressure with whatever levels of force are required.

> We intend to have a wider choice than humiliation or all-out nuclear action.[123]

The Office of the Secretary of Defense conducted several studies of mobility requirements after 1961, but problems remained in determining exact needs, as McNamara acknowledged to a congressional committee in 1964:

> Closely related to the general purpose forces are the airlift and sealift forces required to move them promptly to wherever they might be needed. The requirements for airlift and sealift forces are not susceptible to precise calculation. First, they are subject to most of the same uncertainties which afflict the general purpose forces, the wide variety of possible contingencies, the uncertainties concerning the military strength of our opponents, etc. Second, the quick reaction capability which these forces help to provide can be achieved in a number of ways: by forward deployment of military forces, by the prepositioning of equipment and supplies either on land or in ships, and by the deployment of both men and equipment from a central reserve in the United States. Each of these alternatives has certain advantages and disadvantages. Our present program is based on using a combination of these various methods, but we still have much to learn about the proper balance among them.[124]

Although strategic lift requirements were an important area for the Army, ESSG charged in 1967 that the Army had largely ignored the problem: "OSD, in the absence of Army inputs backed by thorough analyses, has been forced to conduct studies of strategic deployment and transportation matters with which the Army should have been primarily concerned."[125] In 1966 the Army did conduct some studies, which ESSG considered inadequate. Nevertheless, more than five years after President Kennedy's speech, the Army still knew little about its strategic mobility requirements.

The Army's interest in the subject intensified in the mid-1960s as a result of the anticipated procurement of C-5A aircraft and fast deployment logistic (FDL) ships, which would greatly increase American capacity to transport men and supplies.[126] With the Air Force urging development of the C-5A and the Navy promoting the FDL, both of which were still on the drawing boards, the Army feared that its interest as primary user of these new transport vehicles might be slighted. This fear prompted a memorandum from the Chief of Staff of the Army asking DCSOPS to determine Army requirements for strategic mobility resources:

> During the next several years heavy lift aircraft (C-5A) and fast deployment logistic ships will become available in sufficient quantity to significantly influence the rapid deployment posture of the U.S. Army. This improved capability requires detailed study to determine the optimum mix of C-5A aircraft, FDL ships, and prepositioning and resupply requirements.[127]

DCSOPS then asked ESSG to conduct the study that became the first comprehensive Army investigation of its strategic mobility requirements.

When the analysts at ESSG began work on the project, they discovered that an OSD group, including some Army officers, was developing a computer mobility model with the Research Analysis Corporation (RAC), the Army version of Rand. The model considered all the major airlift aircraft, ships, and prepositioned equipment and determined the least-cost mix of each that would be appropriate for any given situation. ESSG analysts worked with this group in refining and testing the new computer model, and the results became a key element in the final ESSG study.[128]

Before using the model to estimate mobility requirements, however, ESSG had to develop a series of hypothetical yet plausible situations that might require the deployment of American forces overseas. As McNamara had implied in 1964, preparing for the huge variety of possible crises that might appear six years hence would make estimates of sealift and airlift requirements either unrealistically high or unnecessarily vague. Working with DCSOPS, the group postulated six situations that represented a range of likely crises, made estimates of the enemy threat and American force requirements, and used the computer model to calculate the most effective and least expensive mix of aircraft, ships, and prepositioned supplies required to transport and support American forces. The study concluded that no single means would be sufficient and that the proper mix depended on a variety of factors including the actual costs of the projected C-5As and FDLs.[129]

A few months later in 1967, ESSG completed a study that complemented the *Army Strategic Mobility Requirements* study.[130] Whereas the strategic mobility study had examined the ability of the military to transport supplies from the United States to overseas theaters, the *Army Intra-Theater LOC Requirements* study investigated the ability to move these supplies within the theater. The intra-theater analysis appeared as one volume of a larger study ordered by the Chief of Staff of the Army on Army general purpose force requirements. The group examined the capacity of Army and Air Force cargo handling and transportation systems to support various deployment schedules postulated in the strategic mobility requirements study. In the situations in which the theater transportation system was unable to handle the personnel, equipment, and supply requirements, ESSG recommended alternative methods of transport and estimated their costs. The study concluded that with minor exceptions the intra-theater transportation system could move the volume of personnel and supplies forecast in the strategic mobility study. The results of these two studies provided the Army with a firm position on its mobility requirements and gave the Army staff the background information it needed for discussions with the other services.

Its work on these two studies led ESSG to urge the Army to take a more active interest in mobility planning: "Overall direction and increased

effort in Army strategic mobility planning is needed to ensure that Army requirements are satisfied."[131] In particular the Army needed to participate in the further development of the RAC/OSD mobility computer model. Beyond the deficiencies in previous mobility work, the ESSG studies had revealed a broader problem in the Army planning process: "There is a vital need to have a general purpose force portfolio of approved scenarios for use as a point of departure for Army studies."[132] The Department of the Army lacked an analytical base for determining its requirements.[133] Without this base, the Army did not have a generally accepted estimate of the military contingencies that the United States might face, how many forces would be needed to deal with them, and how rapidly it might need to deploy forces. This deficiency led directly to the largest ESSG analysis effort of the late 1960s; the studies of force requirements, particularly the SPECTRUM scenarios.

The first study of force requirements had been *Conventional War Forces—1967*, published in 1962. Four years later ESSG conducted a similar, but less voluminous study of NATO force requirements for 1970.[134] After projecting the forces, objectives, and tactics of a possible Warsaw Pact attack, the group analyzed the terrain along the West German border and the problems of defending the area against such an offensive. The study then concluded by estimating the number of American divisions needed to blunt the attack and the consequences that could be expected from having fewer American divisions in Europe. The group also pointed out that acceptance of its figures on the number of divisions was predicated on acceptance of the scenarios postulated in the analysis. While the NATO study provided a continuity with the earlier 1962 effort, the group undertook its most extensive force requirements study in 1968.

The SPECTRUM scenarios study had its origins in the lacuna ESSG noted at the conclusion of its strategic mobility studies—the Army and the Defense Department's lack of an approved set of contingencies. The lack of such agreed upon contingencies meant that each projection of future needs for troops or materiel had to begin by positing the conditions or situations that might require these forces or supplies. The wide diversity of possible situations left the Army without clear and coherent objectives for planning. ESSG designed the SPECTRUM scenarios "to provide a unifying theme and common starting point for the conduct of future studies of requirements for Army units, their readiness, the quantity and location of their equipment and materiel, and the capability to move, employ and sustain these units."[135] According to a former division chief who worked on the project, Major General Richard Wells, "the purpose of these scenarios was to provide a common base that the Army could use in all of its assessments."[136] SPECTRUM was a large task to which ESSG devoted an enormous amount of effort.

While the scenarios were intended as a common ground for military

projections, they were designed to cover a wide variety of possible contingencies. As ESSG noted, the study developed "scenarios employing conventional forces in nonnuclear wars set in the following eight regions to provide worldwide coverage in a range of environments at varying distances from the United States: Northeast Asia, Southeast Asia, Middle East, Europe, Caribbean, South America, Africa, and the Mediterranean."[137] (See figure 25.) In addition, for each of these regions the study addressed three levels of enemy threat and three strategies for each threat level. To obtain a global perspective, ESSG then investigated five "multi-regional contingencies" in which the United States would have to deal simultaneously with a series of situations in a 2½ war scenario.[138] Because all of the crises required the movement of forces and materiel, SPECTRUM included an examination of strategic mobility systems and their ability to support a variety of contingencies. The study was an ambitious undertaking that resulted in ten large volumes, which appeared in August 1968.

Eight volumes covered the various regional contingencies. Each volume began by postulating the 1970–1975 social, economic, and political conditions of the region and identifying its strategic importance to the United States and the Soviet Union. Based on these factors, the study described the possible enemy threats and the support that the United States could expect from friendly forces. For each of three different American force levels and strategies, SPECTRUM then analyzed the development of each military situation after D-Day; the strategic mobility systems required to support each alternative response; and the military, political, and economic implications of each strategy. In another volume ESSG integrated several of these regional scenarios into a number of multiwar situations that might confront the United States (see figure 26). SPECTRUM included almost a hundred different scenarios. It was large enough to retain flexibility without perpetuating the previous confusion.

Although SPECTRUM resembled *Conventional War Forces—1967*, it included a substantially larger number of scenarios. This enlarged scope was due primarily to the ESSG use of computer-simulated war games for SPECTRUM, instead of the manual war games for the earlier study. Using conventional war games developed by RAC and counterinsurgency models from the Stanford Research Institute (SRI), a smaller number of analysts in 1968 developed and tested a larger number of scenarios than had been possible in 1962. As a result, although SPECTRUM was more extensive than *Conventional War Forces–1967*, it was done largely by ESSG personnel without the substantial augmentation from other agencies that the earlier study had required. Even so, in terms of staff hours of effort, SPECTRUM was by far the largest study ESSG produced in the late 1960s.[139]

Because SPECTRUM was so large in terms of its scope and content, it provided numerous conclusions at many levels of generalization. The conclusions, and the assumptions as well, were often interesting. In the survey

REGIONAL DISTRIBUTION OF SPECTRUM SCENARIOS

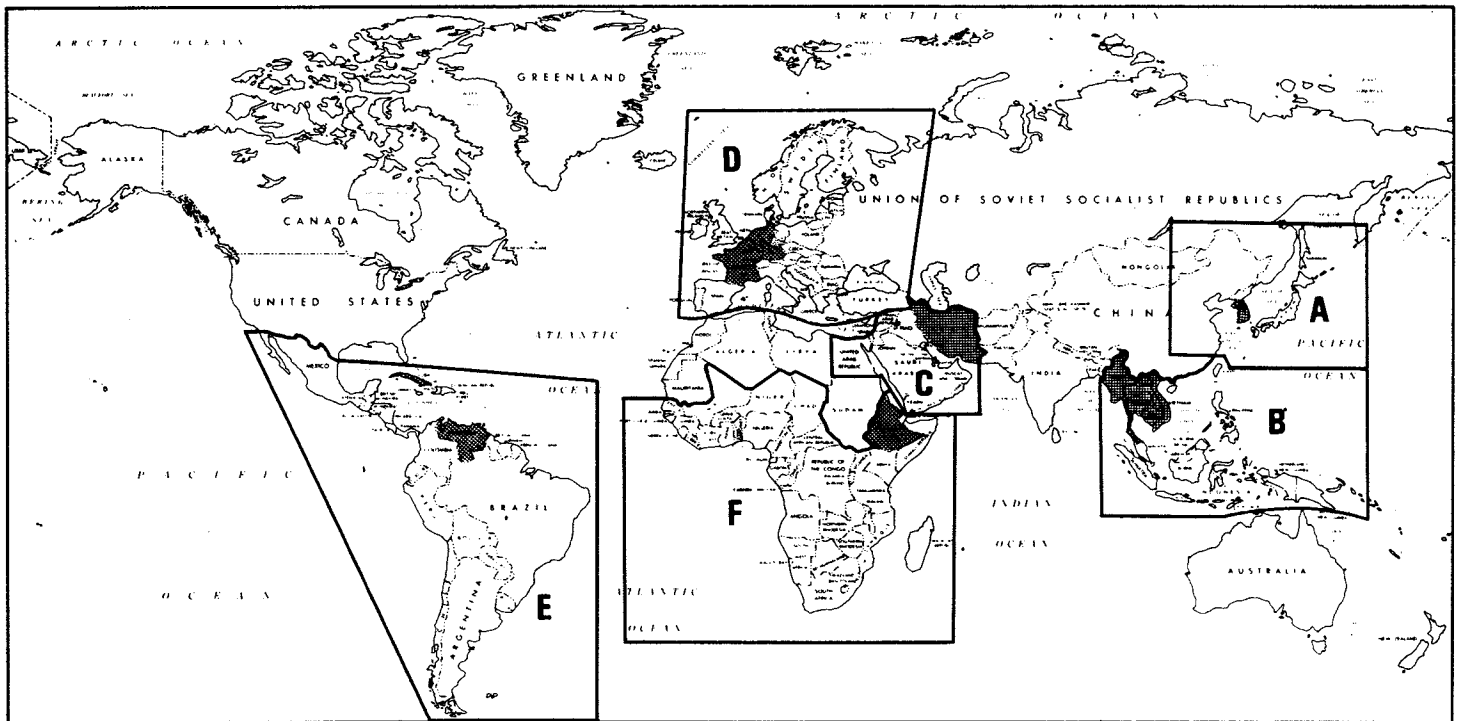

Figure 25

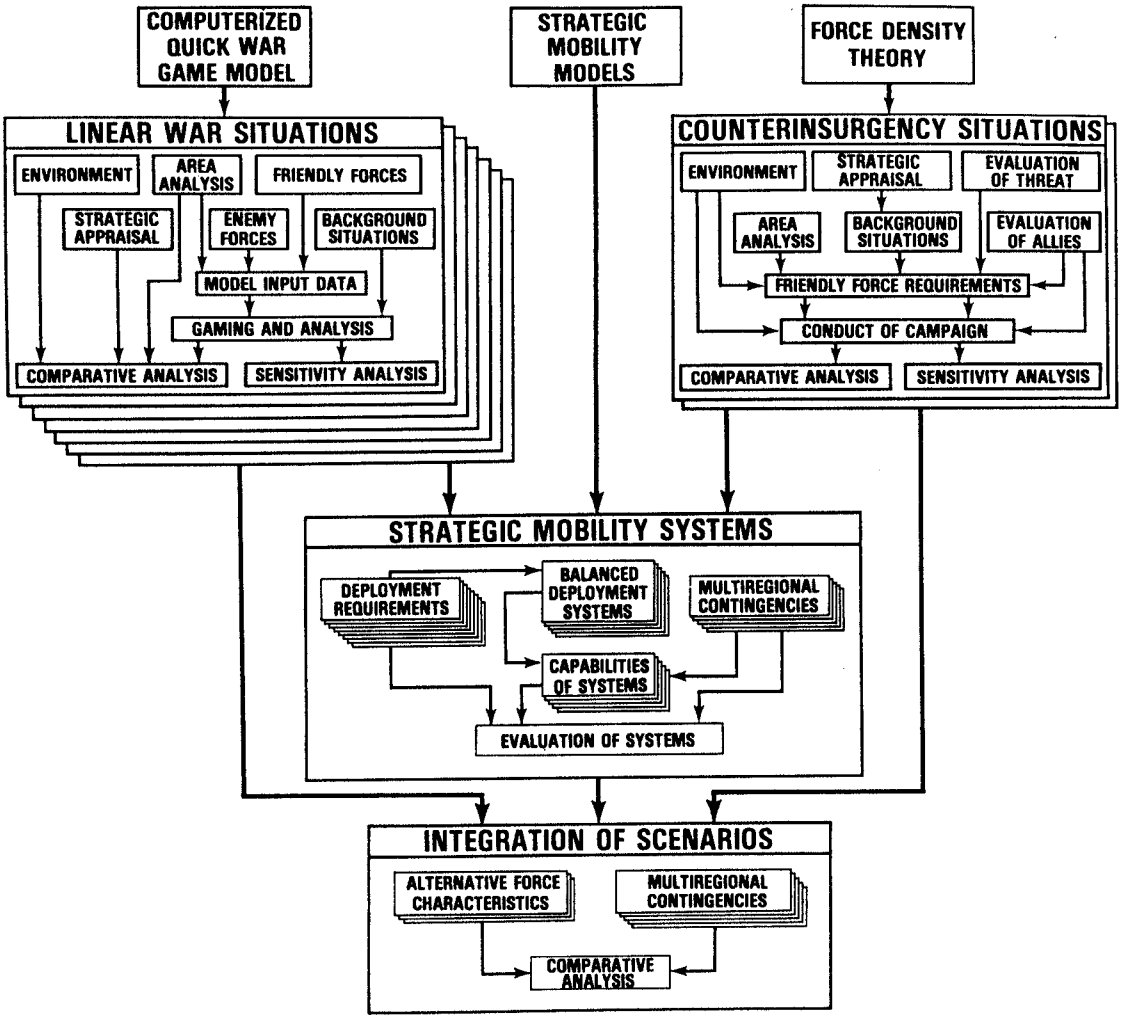

Figure 26

of conditions expected in the early 1970s, the study predicted that the world would become "politically fragmented and less bipolar," creating even more potential problems for the United States.[140] In spite of this fact, the study warned that the United States must keep a clear focus on its major strategic interest: "While the reality of the Soviet ICBMs and the threat of national 'wars of liberation' in the developing world have revised and broadened U.S. strategic problems, they have not relegated Free Europe to a secondary position in our scale of priorities."[141] This was written in 1968 during the war in Vietnam. One theme of the study was a comparison of an American strategy for each contingency that was forward and offensive in nature with a strategy that was defensive and "rearward." The selection of one strategy over the other involved a number of tradeoffs in terms of the total amount of forces that a war would require; the readiness of American

forces; the scope and cost of strategic mobility systems; the total number of casualties; and the political, social, and economic costs of the war for the other nations involved. According to ESSG, all of these factors required calculation and analysis in the process of establishing a national military strategy.[142] The ten volumes of SPECTRUM provided the Army and the Defense Department with a large body of information and analysis.

Although SPECTRUM continued earlier work done by ESSG and others and used many existing techniques, it was still considered an innovative study, as General Wells indicated: "The scope of SPECTRUM was bigger than previous work in the number of different alternatives we looked at. The integration of the strategic mobility aspects was new. No one had really tried that before our strategic mobility study. Many of the tools we used were not new. However, putting this together into one complete package was probably the real significance."[143] SPECTRUM was the starting point for many similar studies, and while the force requirements studies eventually passed to other agencies after the process became more routinized, ESSG had been the catalyst and the originator of the basic study process.

Early in the following year, DCSOPS asked ESSG to compare SPECTRUM with a similar study by the Office of the Secretary of Defense, Systems Analysis (OSD/SA).[144] While the studies required adjustments to make them comparable, ESSG found that the OSD/SA Pilot Study used only one enemy threat level instead of the "envelope of threat" at three levels that ESSG had used. In addition, the Pilot Study threat level was consistently below the intermediate level postulated in SPECTRUM. The Pilot Study also assumed that all allied forces had the same equipment and firepower as American forces, an assumption that ESSG questioned. In the group's opinion, however, the major flaw of the OSD/SA study was its use of static comparisons of manpower between American and enemy forces:

> In no region does the Pilot Study consider the dynamic nature of combat and the inter-relationship during combat of the multiple factors that affect the outcome of the battle. Factors that should be considered include numbers and types of weapons, mobility, weather, the type of terrain, the presence of obstacles, tactical posture, rate of fire, supply consumption, resupply capabilities, casualties and replacements, and the effects of the air war on the land battle. The interactions of these parameters during the battle cannot be adequately considered in static comparisons. War gaming such as that used to develop the SPECTRUM scenarios attempts to consider all important parameters.[145]

SPECTRUM, it seemed, had also started a lively dialogue within the Defense Department over the subject of force requirements.

While ESSG continued to do important work in the area of force requirements in the late 1960s, it did less work on Force Planning Guides than

it had done earlier. After its pioneering work in the early 1960s, much of the responsibility for the guides passed to the Strategy and Tactics Analysis Group (STAG). In 1966, ESSG prepared three updated Engineer Annexes for STAG using the same format that it had developed earlier.[146] In May 1967 the group devoted aproximately 200 staff hours in two days to preparing an Engineer Annex for a hypothetical force to be sent to the Middle East.[147] Using the SPECTRUM scenarios as a basis, the group began a new series of Engineer Annexes in 1969 that extended into the 1970s. The *Force Planning Guide, Southeast Asia*, prepared in 1969, was a mid-range projection for the future and had nothing to do with the existing conflict in Vietnam.[148] Although ESSG continued to work in the area of force structuring, its involvement in the late 1960s was limited because responsibility for the more routinized Force Planning Guide process had passed to another agency.

In the late 1960s the process for determining American general purpose force requirements had moved to a new level of complexity. While studies of the Army force requirements had begun earlier in the decade, the late 1960s saw this process become more subtle and fine tuned with the use of computers and the integration of several scenarios into a variety of multiwar contingencies. Although the complicated problem of strategic mobility had been broached earlier, only after 1965 did the Army devote a substantial effort to investigating movement of troops and supplies to distant points. While, as McNamara had warned, the determination of general purpose force requirements was a complex process, the work that ESSG did in the late 1960s helped raise the endeavor to higher levels of sophistication and lay the basis for more coherent estimation of future Army requirements.

* * *

In the last half of the 1960s, ESSG continued its tradition of mixing work in established areas of its expertise with work in new and innovative fields. At times this new work came in different subject areas, such as force requirements in the early half of the decade, but at other times the work involved new methodologies and techniques. The latter was the case in 1966 when the group established the Special Engineering Division. This new unit had as its purpose the development of "new techniques and procedures for exploiting photo-grammetric and photo-interpretative techniques to acquire environmental and cultural data of use in design studies of major engineering undertakings."[149] Although the techniques and the results were very highly classified then, they are well known today. The new procedure involved the use of very high resolution photography from American satellites.[150] ESSG hoped that analysis of these photographs would be

useful not only for military purposes, but also for civil projects, because the photographs could be used, according to Mr. Orrell, "to gather information and data relative to determining the feasibility of major engineering projects."[151] Instead of sending people into the field to make preliminary surveys and then calculate in detail the operations involved in a project, ESSG hoped that these engineering tasks could be done more cheaply and efficiently with satellite photography.[152]

Because the techniques were novel and highly classified, the group began recruiting new, highly skilled personnel and established strictly controlled working space. In one of its first published studies, the Special Engineering Division examined the feasibility of building a barge canal between Lake Michigan and the Wabash River.[153] The division used the traditional engineering approach and then the new methods of satellite photography to determine the work that would be involved and the costs of building the canal. Although the study proved that the satellite techniques were very valuable, the method was so highly classified that few people could be briefed on the subject. If the results were so restricted, then their usefulness for nonmilitary projects was limited.[154]

In the military area, satellite photography was more useful, especially in projects involving the analysis and selection of sites.[155] ESSG published a series of studies in which the satellite techniques were used "in identifying suitable sites for underground nuclear testing."[156] Another study presented an "evaluation of 14 possible functions for several unidentified structures in a specific foreign country."[157] ESSG did most of these military studies for the Advanced Research Projects Agency (ARPA). Several of them concerned the environmental effects of underground nuclear testing. By the end of 1969, the Special Engineering Division was still recruiting the people it needed, exploring the possible applications of satellite photography, and struggling to deal with the problems caused by the highly classified nature of the work.[158]

* * *

During the rapid buildup of forces in Vietnam in 1965, the American military encountered many logistical and engineering problems similar to those that had occurred at the beginning of World War II and the Korean War. While ESSG had in fact anticipated several of these problems in the series of studies on Southeast Asia published in 1963 and 1964, the process by which the United States became militarily involved in South Vietnam did not develop in a manner that allowed for careful, long-term planning. In spite of the confusion, American military forces did build facilities, move troops and supplies, and begin combat operations, but largely as a result of ingenuity and improvisation. The problems caused by lack of planning and hasty shipment of supplies to South Vietnam were further exacerbated by

the underdeveloped nature of the South Vietnamese economy, the hostile tropical climate, and the already deteriorated military situation. One of the earliest lessons learned in the Vietnam conflict was that some aspects of American logistical planning had to be thoroughly reevaluated.

Major General Daniel A. Raymond helped spark this reappraisal in late 1967 when he released a lengthy report on the difficulties encountered in the American construction program in Vietnam. Although the report contained many recommendations, one of its broadest conclusions was that "adequate base development planning agencies must be established for prospective theaters of operations well in advance."[159] A short time after the report appeared, McNamara and the Joint Chiefs of Staff began a complete review of the Vietnam experience with the intention of establishing planning procedures that would prevent these problems from recurring.[160] A variety of agencies and committees worked on this review for several years and in 1968 the Defense Department published a preliminary manual for planning support facilities.[161] At the request of the Chief of Engineers, ESSG had become involved in the review effort during the previous year, and in October 1967 the group published the first in a long series of studies on base development planning.[162]

Although the notion of base development planning was a new concept, the basic principles went back in ESSG's history to the very first activities of the organization in World War II. The early DA-SLs as well as the more recent Force Planning Guides all contained elements of base development planning; the common features of these planning activities were evident in General Chapman's definition of the new concept: "Base development includes the advance planning and all subsequent actions necessary to provide, in a timely manner, facilities in the quantities, types, and proper locations to enable military forces to initiate and sustain the operations directed in joint contingency operations plans."[163] As Colonel John Coyne pointed out in 1967, "Army doctrine has long recognized the importance of bases for support of tactical forces. Unfortunately the development of specific Army doctrine for base development planning has not kept pace with organizational and technological changes."[164] ESSG's *Base Development Planning Guide* was a preliminary and interim guide for the subject until the Army and the Defense Department could prepare more formal documents. Defense Department policy statements later echoed many of the group's recommendations and conclusions.

ESSG's guide began by reiterating the fundamental relationship between campaign or operations plans and logistical plans: "The basic purpose of the logistics plans, of which the base development plan is a part, is to support the operational plans. Obviously, operation plans cannot be developed in isolation from logistic considerations, but must be developed through an iterative process wherein requirements are compared with available resources."[165] Once the operations and logistical plans had

established the mission of a support base, planners could determine the total number and types of facilities the base would require and the time when each facility would be needed. After subtracting the existing usable facilities on a prospective base site from the total requirements, planners could calculate the amount of new construction required; the schedule for completing each facility; and the amounts of manpower, materiel, and equipment that would be needed. Because even these requirements often could not be met, the base development plan would also have to recommend possible modifications and tradeoffs. Because the entire planning process inherently involved "long lead times for both mobilization of resources and program execution, it is essential that base development plans be prepared in advance and that they be kept current by periodic review."[166] Although the guise was new, base development planning responded to the same planning needs that ESSG had encountered from the beginnings of its existence.

In 1968 and 1969 the group began to provide base development planning support to various Army commands. The first formal plan, published in March 1969, was a revised one for the Army STRIKE Command, and the group had already begun work on several others.[167] Most of ESSG's work in base development during this period was devoted to "developing planning data, improving the planning system, presenting briefings, and preparing papers dealing with planning and doctrine."[168] In the late 1960s the group laid the foundations for base development planning; the bulk of its actual planning came in the next decade.

In its base development planning as well as in its other logistical studies, ESSG continued to be one of the largest users of the Engineer Functional Components System (EFCS). The system received its most extensive operational use during the buildup in Vietnam, and the experiences there had revealed deficiencies. Perhaps the most serious problem was the lack of designs for tropical climates, and the adaptation of existing facilities required a great deal of time and effort. By 1965 the EFCS was also confined primarily to the communications zone, leaving large deficiencies in combat zone facilities. Because the buildup in Vietnam had been so rapid, seldom were enough Engineers and skilled personnel available, and the system contained few pre-engineered or prefabricated components that could be erected by unskilled labor. Even though the EFCS was used to ship large quantities of materiel to Vietnam, these materials and supplies were rarely identified as belonging to the system. Often the components of a single facility were scattered among various ports in Southeast Asia.[169] These problems led ESSG to review the EFCS in 1967.[170]

Although the group had played a major role in developing the system, it recognized the deficiencies. ESSG pointed out that in addition to the problems encountered in Vietnam, the three technical manuals describing the EFCS contained obsolete information and that procedures for updating them were inadequate. The age and inefficiency of computer pro-

grams used to handle the data in the EFCS magnified the problem of keeping current information on such items as supply system stock numbers and costs. According to the study, the EFCS had been "deficient in manpower to update and modernize the system concurrent with maintaining normal operations."[171] Not only had funding and manpower been short, but responsibility for the system was divided among a number of Army agencies, and the various reorganizations of the Army since 1962 had continually changed the lines of responsibility.[172] Confusion and inactivity had resulted. The ESSG study recommended a comprehensive and carefully organized program that would provide the funds and manpower to update the system and keep it current.

In September 1967 several of the responsibilities for the EFCS were transferred to the Directorate of Military Construction of the Office, Chief of Engineers, and in 1968 ESSG abolished its Materiel Planning Division, which had been responsible for the EFCS since the early 1950s.[173] The group felt that the system had become a well-developed and ongoing project and that maintaining and operating it was not compatible with the group's mission as a studies and analysis agency. With the reorganization of the Army along functional lines, the Army's engineer supply system was no longer a responsibility of the Corps of Engineers, and thus the EFCS belonged elsewhere. The system continued to be problem-laden and in 1982 the organization again conducted a study of the system, now called the Army Functional Components System.[174] Although ESSG continued to use the system extensively, its role in developing and operating the EFCS ended in the late 1960s.

The early years of the war in Vietnam revealed many deficiencies in base development planning and in the EFCS. Soon after these problems surfaced, the Army and the Defense Department began to search for solutions. ESSG's central role in base development planning grew out of its extensive experience in this area since World War II. While the EFCS continued in the next decade to lack sufficient development, the group, as a major user of the system, maintained an interest in its expansion and improvement.

* * *

Although ESSG's concerns in the late 1960s ranged widely and included areas as diverse as strategic nuclear weapons, general purpose forces, and satellite photography, the organization continued to work in one of its basic fields of interest—military engineering. Studies relating to the buildup in Vietnam, base development planning, and the EFCS were integral parts of ESSG's involvement in military engineering. In addition, the group did other military engineering studies on a wide variety of topics.

In late 1966, ESSG published a study in the unlikely field of oceanography. The study surveyed the current state of the science in order

to find practical applications of interest to the Army and concluded that "any additional investment in the field should be limited to research and development of basic underwater construction techniques."[175] Later in 1969 the group produced a short study that attempted to develop a quantitative technique for determining which military engineering functions were most important to the Army and how staff effort could be allocated to maximize the effectiveness of these functions.[176]

The group was concerned not only with the military responsibilities of the Chief of Engineers, but also with his role in civil works. In 1967 a Senate bill had proposed transferring the Corps of Engineers' civil works functions to the Department of the Interior, and as ESSG noted, "similar proposals have been made before and no doubt will be made again."[177] In order to arrive at a quantitative measure of the Corps' efficiency in handling civil works projects, ESSG compared the engineering and design and the administrative costs of the Corps and the Bureau of Reclamation for 1969. Although these were not the only costs involved, they were considered a good assessment of management effectiveness. In this comparison, the Corps' costs were 10.7 percent of the total construction program while the bureau's were 17.3 percent, indicating in the group's opinion that the Corps should maintain its civil works activities.[178]

In addition to its civil works functions, the Corps was responsible for providing construction support to the Air Force in theaters of operations. Although serious defects in the system of providing support had been evident before 1965, according to ESSG, "not until the buildup in Southeast Asia had begun did acute deficiencies in the system become evident."[179] Because the war in Vietnam had strained the Corps' ability to complete all the required construction, the Air Force had organized its own construction and repair units and wanted to continue this system. In its study of the problem, ESSG recommended "more clearly delineated areas of responsibility for the Army and the Air Force."[180] The Air Force should be given its own "combat support engineer capability" in order to respond to combat emergencies, but the Army should maintain "responsibility for general support, major construction, and major repair."[181] Since the study recommended "a partial reassignment to the Air Force of present Army roles and missions,"[182] it was bound to be controversial, but ESSG felt that the effectiveness of both services required a small reassignment of roles.

While some of the studies in military engineering, such as the one on oceanography, ranged rather far afield, none compared with the military master plan for Ethiopia.[183] The Military Assistance Advisory Group had requested assistance from ARPA in analyzing some Ethiopian military problems, and ARPA, the primary sponsor for ESSG's special engineering studies, turned to the group.[184] The Imperial Ethiopian Military Forces of Haile Selassie occupied military installations that dated back to World War

II and before. The Ethiopians wanted modern permanent facilities but lacked the personnel to plan them. ESSG sent a team of analysts to Ethiopia to survey existing facilities and to consider "the deployment plans, missions and capabilities of the Imperial Ethiopian Ground Forces in the context of population, economy, communications, geography and the climate."[185] Although the study included no architectural designs, it determined the facilities that the Ethiopians needed to construct in light of the existing deficiencies and the projected requirements. In addition to calculating the construction costs, the three-volume study provided alternative stationing plans that might be more feasible than the original Ethiopian specifications.[186]

Ranging from oceanography to Ethiopia, ESSG investigated a variety of topics in military engineering during the late 1960s. While many of these topics involved only one isolated study, the variety of topics expanded the experience of the group's analysts and gave ESSG a reputation for undertaking innovative and novel projects.

* * *

While studies in military engineering continued to be a staple of ESSG's study repertoire throughout its history, the group produced occasional studies in a variety of other subject areas. At times these episodic areas grew into major concerns, as in the case of management analysis and Army stationing. But some areas, such as the operational feasibility of military systems, never developed beyond periodic interests.

Although several studies in the late 1960s could be classified as management analysis, the field was still an embryonic one for ESSG. One study, a precursor for a number of others in the 1970s, was an investigation of real property maintenance activities (RPMA) in the Army.[187] Published in December 1968, this study was an annex to a larger work performed by an ad hoc committee. The ESSG study focused on the problem of providing RPMA support to Army operations overseas. While specific RPMA requirements varied according to the military contingency, the group maintained that "regardless of the location, nature, size, or duration of an operation, there will be a need for water for drinking, cooling, and washing; power to run essential equipment; shelter of some type, at least for headquarters and administrative units; medical facilities for battle and nonbattle casualties; and fire protection for essential supplies and equipment."[188] Base development was the process of providing facilities; RPMA was the process of maintaining them. While all Army contingency plans provided for RPMA, ESSG discovered no accepted definition or set of requirements. The fundamental problem was ensuring that operations plans forecast reasonable RPMA requirements and that the Army could fulfill them. ESSG concluded that while any type of Engineer unit could contribute to the RPMA mission, the Army needed to be more aware of these activities and train more Engineer troops to perform them.[189]

In another management analysis the group examined the role that indigenous military engineers could play in lesser-developed countries.[190] Published in 1966, this study grew out of concerns generated by the war in Vietnam, although it studied military engineers in a number of countries. While the study concluded that indigenous military engineers had the potential for contributing to "internal stability and internal development," the engineers in most lesser-developed countries could not manage large public works programs on their own.[191] In some countries this capability was increasing, and the study recommended that the United States encourage the use of engineer troops on public works projects by providing funds and training. Although management analysis was still a small area of interest in the late 1960s, the group gained experience in the field.

The variety of changes in the mission, size, and organization of the Army after World War II affected a large number of areas, including the provision of bases for units stationed in the United States. ESSG had studied a number of problems in Army stationing prior to 1965 and continued this work in the late 1960s and beyond. In a study published in 1965 and updated in 1966, the group studied possible sites for the relocation of the Engineer Center and School.[192] ESSG had examined this possibility in 1963, but the units had not been moved, although pressure to put Fort Belvoir to other uses continued. As in the earlier studies, the group evaluated the suitability of other sites in terms of the mission and functions of the center and produced a rank ordering of suitable sites along with the costs of movement and new construction. In 1968, ESSG revised and updated its earlier study of the Army's requirements for division-sized posts.[193] Once again the study established the criteria for posts for each type of division and evaluated possible sites. In addition to calculating the costs of making each site suitable, the study suggested an automated procedure for updating these cost figures annually.

Evaluating the operational feasibility of military systems never became a prime ESSG concern, but the group still occasionally published studies in the area. The major study in this area was in fact a sequel to an earlier study published in 1964.[194] Two years later the group again examined the feasibility of a nuclear-powered energy depot (NPED) system for the Army.[195] The new study was undertaken because the original one failed to include a cost-effectiveness analysis and had not anticipated the increased importance of airlift and air mobility. ESSG contracted with the Stanford Research Institute for extensive technical studies, and after detailed analysis again concluded that the NPED was not preferable to petroleum: "No nuclear powered depot system was found to be operationally or cost-wise competitive with cheap, efficient, abundant, and easily handled and stored petroleum."[196] This conclusion was based on the assumption that "higher prices for POL [petroleum, oils, lubricants] are not expected in the future to the extent that alternative systems would become attractive."[197] Although

the analysts might have wanted to revise this assumption later, they also concluded that the NPED had serious military liabilities: "The NPED in the field would be very vulnerable, easily detected, and easier to put out of action and harder to repair than POL systems."[198] After two comprehensive studies, ESSG recommended against the expenditure of possibly huge sums of money on a new technology that seemed to offer little immediate benefit.

Another study of system effectiveness involved both military hardware and organization. In 1969, DCSOPS asked both ESSG and STAG to evaluate a proposed heavy division force and compare it with American and Soviet divisions, both current and improved versions. In this study as well as others, DCSOPS used the friendly rivalry of its study organization, STAG, and ESSG to provide different perspectives on a common problem.[199] Although the study was completed in 1969, it looked beyond the war in Vietnam to a time in the 1970s when the Army would be "configured to meet European requirements."[200] DCSOPS proposed to deal with Warsaw Pact forces superior in number and armor by modernizing the Army and providing it with the most advanced technology. The proposed new heavy division would have improved firepower, mobility, communications, and intelligence. The ESSG evaluation indicated that the new division would be substantially superior to even improved Soviet forces. This admittedly tentative investigation of the problems facing an Army oriented toward Europe anticipated the doctrinal and organizational questions that faced the Army in the 1970s after the withdrawal from Vietnam.[201]

The three areas of management analysis, Army stationing, and the operational feasibility of military systems illustrated the diversity of both ESSG's interests and expertise. Studies of operational feasibility occurred only sporadically in the group's history, while Army stationing remained a concern of the organization into the 1980s. Management analysis burgeoned in the 1970s to become one of the group's major fields of interest.

* * *

In the late 1960s the variety of ESSG's work and interests grew and diversified. The group added new fields of study, such as special engineering, strategic mobility, and base development planning, which built on older interests but extended them in new directions. In other areas such as nuclear weapons effects or general purpose force planning, which had been a part of the organization's repertory for some years, ESSG used or developed new techniques to increase the scope and sophistication of its studies. And during the first years of the war in Vietnam, the group focused more intensively on a geographic area that rose to unanticipated prominence in American history. In spite of the growing effect of the war, ESSG continued to devote most of its effort to mid- and long-range planning for the wide variety of problems that faced the American military establish-

ment. While the concerns of the Johnson administration centered to a large extent on Southeast Asia, the war had less influence on the history of ESSG. The diversity of its interests and the breadth of its expertise followed a pattern that had been established prior to 1965—a pattern that directed the organization toward growth and innovation.

Notes for Chapter V

1. For a discussion of the growth of the Soviet nuclear arsenal, see Jerome H. Kahan, *Security in the Nuclear Age: Developing U.S. Strategic Arms Policy* (Washington, DC: Brookings Institution, 1975), pp. 113–117.

2. Interviews with Maj. Gen. Bennett Lewis, USA (Ret.), Washington, DC, 19 May 1981; George H. Orrell, Washington, DC, 7–8 Oct. 1981; and Dean E. Considine, Washington, DC, 2 Oct. 1981.

3. Kahan, *Security in the Nuclear Age*, pp. 97–98; and Desmond Ball, *Politics and Force Levels: The Strategic Missile Program of the Kennedy Administration* (Berkeley, CA: Univ. of California Press, 1981), pp. 46–48.

4. Quoted in Kahan, *Security in the Nuclear Age*, p. 94.

5. Ibid., pp. 94–99.

6. Ibid., pp. 99–101.

7. Ibid., pp. 101–105.

8. Ibid.

9. Interview with John J. Taylor, Washington, DC, 18 July 1980.

10. Ibid.

11. ESC, *Strategic Offensive Forces*, no. 136 (Feb. 1966); ESC, *Strategic Offensive Forces Analysis*, no. 161 (July 1968); ESC, *Comparison of Proposed Strategic Bombers*, no. 144 (Aug. 1966); and ESC, *Requirements for Bomber Delivered Strategic Weapons, 1972–75*, no. 148 (June 1967).

12. ESC, *Strategic Offensive Forces.*

13. Ibid., p. F-1.

14. Ibid., p. A-1.

15. Ibid., p. D-4.

16. ESC, *Comparison of Proposed Strategic Bombers*, p. 2.

17. Ibid., p. 25.

18. Ibid., p. 26.

19. Ibid., p. 40.

20. Ibid., p. 2.

21. Interview with Mr. Taylor.

22. ESC, *Analysis of a Soviet Anti-Ballistic Missile Defense*, no. 131 (June 1965).

23. Interview with Mr. Taylor.

24. Ibid. See also the interview with Col. William B. Wootton, USA (Ret.), San Francisco, CA, 7 Nov. 1980.

25. Interview with Mr. Taylor.

26. Ibid. See also the interview with Col. Wootton.

27. Interview with Mr. Taylor.

28. ESC, *Selection of Strategic Target Systems That Influence Post-SIOP Ground Operations*, no. 137 (Nov. 1966).

29. Interview with Mr. Taylor. See also Project Summary and Directives, 1968, Engineer Studies Center (ESC), Records of the U.S. Army Corps of Engineers, RG 77, Washington National Records Center (WNRC), Suitland, MD.

30. ESC, *Study of ADM Employment*, no. 123 (May 1965), I: ix.

31. Ibid., p. 3.

32. Ibid.

33. ESC, *Atomic Demolition Munitions, An Employment Concept*, no. 130 (July 1965), I: v.

34. *Study of ADM Employment* is the original ESSG study and *Atomic Demolition Munitions* is the study as released by DCSOPS.

35. ESC, *Atomic Demolition Munitions*, I: 16.

36. Ibid., pp. 5 and 11.

37. Ibid., p. 30.

38. Ibid., p. 3.

39. ESC, *Demolition Employment in the Pacific Theater. Part I: Korea*, no. 151 (Oct. 1967); and ESC, *Demolition Employment in the Pacific Theater. Part II: Southeast Asia*, no. 196 (Aug. 1970).

40. ESC, *Concept for COMMZ Operations in Nuclear War (1968–1972)—A Substudy of Project OREGON TRAIL*, no. 128 (Jan. 1965). The earlier studies were ESC, *Theater Operations in a Nuclear Environment (Europe) 1968–1972—A Substudy of Project OREGON TRAIL*, no. 105 (Sept. 1964); and ESC, *Theater Replacements in a Nuclear War (1968–1972)—A Substudy of Project OREGON TRAIL*, no. 104 (Dec. 1964).

41. ESC, *Concept for COMMZ Operations in Nuclear War*, p. 4.

42. Ibid., p. vii.

43. Ibid.

44. Ibid., p. 27.

45. Maj. Gen. Robert R. Ploger, "Post-Attack Viability of the United States," *The Military Engineer* 61 (Sept.-Oct. 1969): 317.

46. Ibid.

47. ESC, *Post-Attack Mobilization of the U.S. Army—1963*, no. 67 (July 1961).

48. ESC, *Analysis of Army Survival Measures III*, no. 160 (May 1967), p. xi.

49. ESC, *The United States and the Post-Attack World Environment*, no. 121 (Mar. 1965), p. iii.

50. Ibid., p. v.

51. Ibid.

52. Ibid., p. 68.

53. ESC, *Measures of Effectiveness of Attack*, no. 125 (June 1965), p. 1.

54. Ibid., p. 2.

55. Interview with Lloyd Addington, Washington, DC, 18 Aug. 1981.

56. ESC, *Measures of Effectiveness of Attack*, p. 3.

57. Interviews with Mr. Addington and Col. Wootton.

58. Interview with Mr. Addington.

59. ESC, *United States Labor Force—1975*, no. 133 (June 1966).

60. ESC, *United States Industry—1975*, no. 147 (June 1967).

61. Interview with Mr. Addington.

62. ESC, *United States Labor Force*, p. v.

63. ESC, *Post-Attack Viability of the United States—1975*, no. 150 (Jan. 1967), p. ix. The following discussion of PAVUS-75 is also based on extensive information provided by Mr. Addington.

64. Ploger, "Post-Attack Viability," p. 138.

65. Ibid.

66. Ibid.

67. Ibid., pp. 318–319.

68. Ibid., p. 319. See also the interview with Col. Wootton.

69. Ibid., p. 319; and interview with Col. John C. Coyne, USA (Ret.), Coupeville, WA, 4 Nov. 1980.

70. Interview with Mr. Addington. See also the interview with Col. Coyne.

71. Ploger, "Post-Attack Viability," p. 319.

72. Ibid., p. 317.

73. Ibid.

74. ESC, *Analysis of Army Survival Measures*, no. 132 (May 1965), p. v.

75. Ibid. ESC, *Analysis of Army Survival Measures II*, no. 146 (May 1966); ESC, *Analysis of Army Survival Measures III*, no. 160 (May 1967).

76. ESC, *Analysis of Army Survival Measures*, p. 5.

77. William E. Main, "Army Survival Measures Against Nuclear Attack," *The Military Engineer* 62 (Sept.-Oct. 1970): 323–324.

78. ESC, *Army Survival Measures Planning Guide*, no. 155 (Sept. 1967), DA Pamphlet 500–1; ESC, *Army Survival Measures Planning Guide*, no. 154 (Sept. 1967), DA Pamphlet 500–1–1; and ESC, *Army Survival Measures Planning Guide for Reserve Components*, no. 153 (Sept. 1967), DA Pamphlet 500–2.

79. Project Summary and Directives, 1970, ESC, RG 77, WNRC.

80. ESC, *Improvement of the Military Damage Assessment System*,

no. 180 (Aug. 1969).

81. George C. Herring, *America's Longest War: The United States and Vietnam* (New York: Wiley, 1979), pp. 145–182.

82. Interview with Mr. Orrell.

83. ESC, *South Vietnam Engineer Estimate Pleiku-Kontum*, no. 124 (Mar. 1965); and ESC, *Engineer Estimate U.S. Army Corps Force, Southeast Asia*, no. 126 (Apr. 1965). See also the interviews with Mr. Orrell, Mr. Considine, and Col. Wootton. For a survey of Engineer activities in South Vietnam, see Maj. Gen. Robert R. Ploger, *U.S. Army Engineers, 1965–1970*, Vietnam Studies (Washington, DC: Government Printing Office, 1974).

84. ESC, *Thailand Construction Requirements*, no. 122 (Oct. 1965), p. iii.

85. Ibid., p. 1.

86. ESC, *Ports and Beaches, Southeast Asia,* no. 138 (Aug. 1966), I: 2.

87. Ibid., p. 6. See also the interviews with Maj. Gen. Richard M. Wells, USA (Ret.), Portland, OR, 6 Nov. 1980; and Mr. Considine.

88. ESC, *Offshore Logistics Support, Southeast Asia*, no. 140 (July 1966); and ESC, *Offshore Logistics Support, Southeast Asia, Addendum*, no. 139 (Dec. 1966). See also the interviews with Mr. Orrell and Col. Wootton.

89. ESC, *Offshore Logistic Base, Western Pacific*, no. 167 (June 1968), I: 1.

90. Ibid., p. 37.

91. Interview with Mr. Orrell.

92. Ibid.

93. Neil Sheehan et al., *The Pentagon Papers as published by the New York Times* (New York: Bantam Books, 1971), pp. 494 and 504–506.

94. Ibid., pp. 494–495 and 513–519.

95. Interview with Mr. Orrell.

96. ESC, *Border Control Systems, South Vietnam*, no. 145 (Oct. 1966).

97. Ibid., I: 100–101. See also the interviews with Mr. Considine and Col. Wootton.

98. Interview with Gen. Wells.

99. For another discussion of the "McNamara Line," see Guenter Lewy, *America in Vietnam* (New York: Oxford Univ. Press, 1978), pp. 65–66.

100. Memorandum from Robert S. McNamara, Secretary of Defense, to the Secretary of the Army, Subject: Line of Communications Study—Southeast Asia and Korea, 9 Nov. 1967, reprinted in ESC, *Validation Plan for Road Capacity Estimating Methods*, Unnumbered (Dec. 1968), p. A-8.

101. Ibid.

102. Ibid.

103. Letter from Col. John C. Coyne, Chief/ESSG, to DCSOPS, 5 Dec. 1967, reprinted in ibid., p. A-14.

104. Ibid., A-15.

105. Ibid. See also the interview with Col. Coyne.

106. ESC, *Evaluation of Methods for Estimating Capacities of Lines of Communications*, no. 170 (Mar. 1968).

107. Ibid., p. 7. See also the interview with Col. Coyne.

108. ESC, *Road Capacity Estimating Methods, Final Report on Seminar*, no. 163 (Nov. 1968).

109. Ibid., pp. B-4 and B-5.

110. ESC, *Evaluation of Methods for Estimating Capacities of Lines of Communications*, p. 21; and interview with Col. Coyne.

111. Memorandum from Alain Enthoven, Assistant Secretary of Defense, to the Under Secretary of the Army, 30 Dec. 1968, reprinted in ESC, *Interdiction of Lines of Communication*, no. 193 (Feb. 1970), Annex A.

112. ESC, *Interdiction of Lines of Communication*, p. xviii.

113. Ibid., p. xix.

114. ESC, *Post-Hostilities Planning Actions*, no. 149 (Apr. 1967), p. 1.

115. ESC, *An Analysis of the Requirement for Army Aircraft Shelters*, no. 186 (Sept. 1969); and interview with Mr. Orrell.

116. Letter from Col. Robert M. Montague, Jr., Coordinator of Army Studies, to Col. John P. Chandler, Chief/ESSG, 15 Oct. 1969, ESC Historical Files.

117. Interview with Gen. Wells. See also the interview with Col. Wootton.

118. Annual Historical Summary, FY 69, ESC Historical Files.

119. Interview with Mr. Orrell.

120. Ibid.

121. Ibid.

122. Interview with Mr. Considine.

123. Quoted in ESC, *Army Strategic Mobility Requirements*, no. 156 (Apr. 1967), IV: I-3. For discussions of strategic mobility, see Alain C. Enthoven and K. Wayne Smith, *How Much Is Enough? Shaping the Defense Program, 1961–1969* (New York: Harper and Row, 1971), pp. 234–243; and William W. Kaufmann, *Planning Conventional Forces, 1950–1980* (Washington, DC: Brookings Institution, 1982), pp. 10–11.

124. Quoted in ESC, *Army Strategic Mobility Requirements*, IV: I-4.

125. Ibid., p. I-7.

126. Ibid.

127. Memorandum from the Chief of Staff of the Army to DCSOPS, 29 Sept. 1966, reprinted in ibid., I: A-8.

128. Interviews with Mr. Orrell and Gen. Wells.

129. Interviews with Mr. Orrell, Gen. Wells, and Mr. Considine.

130. ESC, *Army General Purpose Force Requirements Portfolio, Vol. VI: Army Intra-Theater LOC Requirements*, no. 157 (June 1967).

131. Ibid., p. 58.

132. Ibid., p. xvii.

133. Interview with Mr. Considine.

134. ESC, *NATO Land Force Requirements*, no. 141 (June 1966); and interview with Gen. Wells.

135. ESC, *Portfolio of General Purpose Force Requirements Scenarios*, no. 166 (Sept. 1968), I: 2.

136. Interview with Gen. Wells.

137. ESC, *Portfolio of General Purpose Force Requirements Scenarios*, I: 1. See also the interview with Gen. Wells.

138. Interviews with Col. Coyne and Mr. Considine.

139. Interviews with Mr. Considine, Col. Coyne, and Gen. Wells. See also Limited War Analysis Division—Activities: Five-Year Summary, 1965-1970, ESC, RG 77, WNRC.

140. ESC, *Portfolio of General Purpose Force Requirements Scenarios*, I: 17.

141. Ibid.

142. Ibid., pp. 351-352; and interview with Gen. Wells.

143. Interview with Gen. Wells. See also the interview with Col. Coyne.

144. ESC, *Comprehensive Review of the OSD/SA Pilot Study on General Purpose Force Requirements*, no. 184 (Feb. 1969); and the interview with Mr. Considine. See also Project Summary and Directives, 1969, ESC, RG 77, WNRC.

145. ESC, *Comprehensive Review of the OSD/SA Pilot Study*, p. 6.

146. ESC, *Force Planning Guide, Southeast Asia, Revision—Engineer Annex*, Unnumbered (Apr. 1966); ESC, *Force Planning Guide, Europe, Revision—Engineer Annex*, Unnumbered (May 1966); ESC, *Force Planning Guide, Korea, Revision—Engineer Annex*, Unnumbered (Oct. 1966). See also the interviews with Gen. Wells, Mr. Orrell, and Mr. Considine.

147. ESC, *Analysis of Engineer Requirements in Support of COMUSJTF-ME OPLAN 531/1A*, no. 158 (May 1967).

148. ESC, *Force Planning Guide, Southeast Asia—Engineer Annex*, no. 182 (Mar. 1969); and interview with Mr. Considine.

149. Annual Historical Summary, FY 67, ESC Historical Files.

150. Interviews with Mr. Orrell, Col. Coyne, and Col. Wootton.

151. Interview with Mr. Orrell.

152. Ibid.

153. ESC, *Lake Michigan-Wabash River Barge Canal*, no. 168 (Dec. 1968); Annual Historical Summary, FY 69, ESC Historical Files; and interview with Col. Coyne.

154. Interview with Mr. Orrell.

155. Annual Historical Summary, FY 68, and ESSG Functional Statement (22 July 1968), ESC Historical Files.

156. ESC, *Bibliography of Publications*, p. 69-7. See also Annual Historical Summary, FY 69, ESC Historical Files.

157. ESC, *Bibliography of Publications*, p. 69-7.

158. Interview with Mr. Orrell. The other studies of special engineering were ESC, *Underground Nuclear Testing—Environmental Effects I and II*, nos. 172-173 (June and Dec. 1969); and ESC, *Suspect Advanced Weapons Related Facilities*, no. 174 (July 1969).

159. Maj. Gen. Daniel A. Raymond, "Observations on the Construction Program, RVN, 10 October 1965—1 June 1967." For another account of base development by an officer assigned to Vietnam, see Lt. Gen. Carroll H. Dunn, *Base Development in South Vietnam, 1965-1970*, Vietnam Studies (Washington, DC: Government Printing Office, 1972). ESSG assisted in preparing this book.

160. Maj. Gen. Curtis Chapman, "Base Development," *The Engineer* 1 (Fall 1971): 15; and interview with Mr. Orrell.

161. Office of the Deputy Assistant Secretary of Defense for Properties and Installations, *Base Development for Contingency Operations* (Washington, DC: Government Printing Office, 1968).

162. ESC, *Base Development Planning Guide*, no. 152 (Oct. 1967). See also the interview with Edward W. King, Washington, DC, 13 May 1981.

163. Chapman, "Base Development," p. 15.

164. ESC, *Base Development Planning Guide*, p. vi; and interview with Mr. King.

165. Ibid., p. 4.

166. ESC, *Base Development for Contingency Operations*, pp. 1-2.

167. ESC, *CINCARSTRIKE Base Development Plan 7706*, no. 185 (Mar. 1969); and interview with Mr. King.

168. Annual Historical Summary, FY 69, ESC Historical Files.

169. Ralph Reynolds, "The Engineer Functional Components System and Its Application in Southeast Asia," 6 Oct. 1969, ESC Historical Files; interview with Col. Wootton; and ESC, *Analysis of the Engineer Functional Components System*, no. 159 (June 1967).

170. ESC, *Analysis of the Engineer Functional Components System.*

171. Ibid., p. 4.

172. Interview with Mr. Orrell.

173. Annual Historical Summary, FY 68, ESC Historical Files.

174. Interviews with Mr. Orrell and Col. Coyne.

175. ESC, *Study and Analysis of Literature and Concepts of Oceanography*, no. 135 (Dec. 1966), p. vii.

176. ESC, *Military Engineering: An Assessment Methodology*, no. 178 (Mar. 1969).

177. ESC, *A Quantification of the Value of Civil Works—Comparison of Engineering and Design and Supervision and Administration Costs*, no. 175 (Jan. 1969), p. 2.

178. Ibid., p. 6.

179. ESC, *Construction Support of the USAF in Theaters of Operations*, no. 183 (June 1969), p. ix.

180. Ibid., p. 18.

181. Ibid., pp. 18 and 21.

182. Ibid., p. 26.

183. ESC, *Military Master Planning Ethiopia*, no. 177 (June 1969).

184. Interview with Mr. Orrell.

185. ESC, *Military Master Planning Ethiopia*, p. xxiii.

186. Ibid.; and interview with Mr. Orrell.

187. ESC, *RPMA Support to Army Contingency Plans*, no. 162 (Nov. 1968).

188. Ibid., p. U-7.

189. Ibid., pp. U-5 and U-10.

190. ESC, *Indigenous Military Engineers and Public Works in Lesser Developed Countries*, no. 142 (Feb. 1966).

191. Ibid., p. 71.

192. ESC, *Engineer Center and School Relocation Study*, no. 127 (May 1965); and ESC, *Supplement to Engineer Center and School Relocation Study*, no. 134 (Nov. 1966). See also the interview with Col. Wootton.

193. ESC, *Division Stationing Analysis*, no. 171 (July 1968). An individual study was also done on Fort Polk: ESC, *Requirement for Fort Polk as a Permanent Army Installation*, no. 164 (June 1968).

194. ESC, *An Operational Analysis of Nuclear-Powered Energy Depot Systems for the Army. A Potential Revolution in Field Logistics*, no. 111 (Feb. 1964).

195. ESC, *Cost-Effectiveness of the Nuclear-Powered Energy Depot (NPED) for the Army Field Forces*, no. 143 (June 1966).

196. Ibid., p. vi.

197. Ibid., p. 72.

198. Ibid.

199. Interview with Mr. Considine.

200. ESC, *Evaluation of U.S. Heavy Division Force*, no. 181 (Sept. 1969), p. 2.

201. Interview with Mr. Considine; and Robert A. Doughty, *The Evolution of U.S. Army Tactical Doctrine, 1946–1976*, Leavenworth Papers, no. 1 (Fort Leavenworth, KS: Combat Studies Institute, 1979).

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